Sampling Episode Report
Holland America Oosterdam
Sampling Episode 6506

Chapter 4
Results and Discussion

March 2006

4.0 RESULTS AND DISCUSSION

This section presents the data collected during this sampling episode. Section 4.1 presents the analytical results and discussion; Section 4.2 presents interview results for activities that impact wastewater generation; and Section 4.3 presents flow data and analysis. Analytical results for field measurements performed onboard are presented in Appendix A-3. Note that anomalous analytical results were obtained for ammonia and total and available cyanide; these data have not been excluded from the data set, but the results are presented and discussed in Sections 5.1.1 and 5.1.2 (in the data quality section of this report) and not in the current section. During the 2005 cruise season, EPA conducted a supplementary sampling program to collect additional ammonia data to better assess this analyte in cruise ship wastewater (See Section 5.1.2).

4.1 Laboratory Analytical Results and Discussion

4.1.1 Graywater

Table 4-1 presents analytical results for laundry, accommodations, food pulper, and galley wastewaters, which were sampled for one 24-hour period. Only those analytes detected at least once in any wastewater samples (i.e., graywater sources, influents to treatment systems, or effluents from treatment systems) are included in this table. Appendices A-1 and A-2 present results for both detected and nondetected analytes.

Of the 290 analytes tested for in the graywater sources, 65 were detected in these waste streams. Fifteen of these 65 analytes were also detected at some level in the equipment blank (flagged by an "e" in Table 4-1; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of these analytes to the samples. EPA will consider the impact of possible contamination from sampling equipment in a future analysis. Twenty-nine of these 65 detected analytes were also detected at some level in the potable water used as source water for all graywater systems (flagged by an "s" in Table 4-1; see Table 4-14

for source water results), meaning that the source water may have contributed some or all of these analytes to the samples.

Chart 1 presents the number of analytes detected in each graywater source.

Chart 1. Number of Analytes Detected in Graywater Sources

Analyte Group (a)	Number of Analytes Detected			
	Laundry	**Accommodations**	**Food Pulper (b)**	**Galley**
Pathogen Indicators	3	3	3	3
Classical Pollutants	13	13	9 (b)	14
Total and Dissolved Metals	30	34	16 (b)	33
Volatile and Semivolatile Organics	3	3	0	3
Total	**49**	**53**	**28**	**53**

(a) See Table 3-3 for information on analyte groups.
(b)Food pulper wastewater was not analyzed for hardness, HEM/SGT-HEM, TDS, TSS, and dissolved metals due to the high solids content of the sample (see Table 3-5).

Chart 2 presents the number of analytes that were detected in each graywater source at the highest concentration. For example, the highest detected concentrations for two of the pathogen indicators were found in the food pulper wastewater, while the highest detected concentration for the third indicator was found in the accommodations wastewater. Note that a graywater source that has the highest concentration of an analyte will not necessarily contribute the greatest amount of that analyte to the wastewater treatment system. The total amount of an analyte contributed by a particular graywater source also will depend on that source's volume compared to the volumes of the other sources. Flow (and thus volume) information was not able to be collected for all graywater sources (see Table 2-1).

Chart 2. Number of Analytes Detected at Highest Concentration in Graywater

Analyte Group(a)	Number of Analytes Detected in Graywater	Number of Analytes Detected at the Highest Concentration			
		Laundry	Accommodations	Food Pulper (b)	Galley
Pathogen Indicators	3	0	1	2	0
Classical Pollutants	14	0	1	9 (b)	4
Total and Dissolved Metals	43	5	28	1 (b)	9
Volatile and Semivolatile Organics	5	2	1	0	2
Total	**65**	**7**	**31**	**12**	**15**

(a) See Table 3-3 for information on analyte groups.
(b)Food pulper wastewater was not analyzed for hardness, HEM/SGT-HEM, TDS, TSS, and dissolved metals due to the high solids content of the sample (see Table 3-5).

Food pulper wastewater contained a total of 28 analytes and showed the highest concentration for 12 analytes. Most notably, food pulper wastewater showed the highest concentrations for several analytes commonly used to measure wastewater strength: biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), and total organic carbon (TOC).

Accommodations wastewater contained the greatest number of analytes detected at the highest concentration (31 out of 65 detected analytes). Accommodations wastewater had the highest concentrations of *E. coli* and enterococci, and most metals. Fifty-three of the 65 analytes detected in graywater sources were detected in accommodations wastewater.

Galley wastewater contained 53 of the 65 analytes detected in graywater sources and showed the highest concentration among the graywater sources for 15 of the analytes, including 4 classical pollutants, several metals (most notably total and dissolved lead, and dissolved copper), 4-chloro-3-methylphenol, and phenol. Galley wastewater was the only graywater source that was analyzed for pesticides because this was the most likely possible source; none were detected.

Laundry wastewater contained a total of 49 analytes and showed the highest concentration for 7 analytes (the least among the graywater sources). Most notably, the laundry contributed the highest concentrations of bis(2-ethylhexyl)phthalate and chloroform. Laundry

wastewater was the only graywater source that was analyzed for dioxins and furans because this was the most likely possible source of these analytes; none were detected.

4.1.2 Influent to Graywater Treatment System

Table 4-2 presents analytical results for the influent to the ROCHEM graywater treatment system, which was sampled for five consecutive 24-hour sampling periods. Only those analytes detected at least once in any of the wastewater samples (i.e., graywater sources, influents to treatment systems, or effluents from treatment systems) are included in this table. Appendices A-1 and A-2 present results for both detected and nondetected analytes.

Pathogen Indicators and Classical Pollutants

All 3 pathogen indicators and all 15 classical pollutants were detected in the influent to the graywater treatment system samples. One of these 18 analytes (hardness) was also detected at some level in the equipment blank (flagged by an "e" in Table 4-2; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of this analyte to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Seven of these detected analytes were also detected at some level in the potable water used as source water for all graywater and sewage systems (flagged by an "s" in Table 4-2; see Table 4-14 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples. Note that anomalous analytical results were obtained for ammonia; these results are presented and discussed in Section 5.1.2.

Chart 3 compares the influent to the Oosterdam graywater treatment system to typical domestic wastewater for selected pathogen indicators and classical pollutants. Key analytes commonly used to assess wastewater strength, such as BOD_5, TSS, and COD, were detected in the Oosterdam influent to graywater treatment at concentrations similar to those in typical domestic wastewater, even though this treatment system does not treat any sewage.

Chart 3. Comparison of Influent to Oosterdam Graywater Treatment System to Untreated Domestic Wastewater

Analyte	Influent to Oosterdam Graywater Treatment System	Untreated Domestic Wastewater (a)
Enterococci	10^2 to 10^3 MPN/100 mL	10^2 to 10^3 number/100 mL
Fecal Coliform	10^6 to 10^7 CFU/100 mL	10^4 to 10^5 number/100 mL
Biochemical Oxygen Demand (BOD_5)	132 to 149 mg/L	110 to 400 mg/L
Chemical Oxygen Demand (COD)	335 to 538 mg/L	250 to 1,000 mg/L
Nitrate/Nitrite	0.0110 to 0.120 mg/L	0 mg/L
Oil and Grease	37.0 to 143 mg/L	50 to 150 mg/L
Total Phosphorus	0.850 to 3.94 mg/L	4 to 15 mg/L
Total Suspended Solids (TSS)	73.0 to 99.0 mg/L	100 to 350 mg/L

(a) Source: Metcalf & Eddy, *Wastewater Engineering*, Third Edition, 1991.

Total and Dissolved Metals

Of the 34 metal analytes detected in the influent to graywater treatment samples, 26 were detected in every influent to treatment sample (Table 4-2). Twelve of these 34 analytes were detected at some level in the equipment blank (flagged by an "e" in Table 4-2; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of these analytes to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Twenty of these detected analytes were also detected at some level in the potable water used as source water for all graywater systems (flagged by an "s" in Table 4-2; see Table 4-14 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples.

The 10 metal analytes detected at the highest concentrations were: total and dissolved sodium, total and dissolved calcium, total zinc, total and dissolved aluminum, total and dissolved magnesium, and total iron. Total and dissolved chromium, total and dissolved copper, total and dissolved lead, total and dissolved nickel, and total and dissolved zinc are priority pollutant metals (designated by EPA in 40 CFR Part 423, Appendix A) that were detected in every influent to graywater treatment sample. Some metals may result from carbon steel and stainless steel pipe and tanks in the ship.

Semivolatile and Volatile Organics, Pesticides, PCBs, and Dioxin and Furans

Among the 80 target analytes for volatile and semivolatile organics, only 4 were detected in any Oosterdam influent to graywater treatment samples: 1 volatile organic, and 3 semivolatile organics (Table 4-2). Many of these analytes were detected at concentrations close to their detection limits. Phenol was detected in the equipment blank (see Table 5-3 for equipment blank results) (volatile organics were not analyzed for in the equipment blank). EPA will consider the impact of possible contamination from sampling equipment in a future analysis.

The three semivolatile organics detected in the influent to graywater treatment were: bis(2-ethylhexyl)phthalate, diethyl phthalate, and phenol. Bis(2-ethylhexyl)phthalate and diethyl phthalate are plasticizers (chemicals added to plastics to make them flexible) and are commonly detected in environmental samples (ATSDR, 2002 and ATSDR, 1996). Cruise ships use a wide variety of plastic products (e.g., floor tiles, shower curtains, hoses, packaging materials and containers, PVC piping) that may result in the presence of these plasticisers in the influent to graywater treatment.

Phenol is both man-made and produced naturally. It is found in human wastes (urine). It is also found in some foods (smoked summer sausage, fried chicken, mountain cheese, some species of fish). Man-made sources include the use of phenol as a slimicide, as a disinfectant, and in medicinal preparations such as ointments, ear and nose drops, and antiseptic wipes (ATSDR, 1998). All of these are possible sources for the presence of phenol in cruise ship wastewater. Phenol was also detected in the source water (see Table 4-14 for source water results), meaning that the source water may have contributed some or all of this analyte to the samples.

The one volatile organic detected in the influent to treatment was toluene. Toluene occurs naturally in crude oil and is used to produce gasoline, other fuels, and coal. It is also used to make paints, paint thinners, fingernail polish, adhesives, and rubber (ATSDR, 2001).

Pesticides, PCBs, and dioxins and furans were not analyzed for in the influent to the Oosterdam wastewater treatment system.

4.1.3 Influent to the Ultraviolet (UV) Disinfection Part of the Graywater Treatment System

Table 4-3 presents pathogen indicator results for the influent to UV disinfection part of the Oosterdam graywater treatment system. Grab samples for pathogen indicator analyses were collected at this sampling point for five consecutive 24-hour sampling periods. Pathogen indicators, which were generally in the thousands to millions at the influent to the treatment system (see Table 4-2), were reduced by three orders of magnitude after reverse osmosis (i.e., before the UV disinfection step). Data for pathogen indicators in the final effluent (i.e., after the UV disinfection step) are presented in the next section.

4.1.4 Effluent from Graywater Treatment System

Table 4-4 presents analytical results for the effluent from the graywater treatment system, which was sampled for five consecutive 24-hour sampling periods. Only those analytes detected at least once in any of the wastewater samples (i.e., graywater sources, influents to treatment systems, or effluents from treatment systems) are included in this table. Appendices A-1 and A-2 present results for both detected and nondetected analytes.

Pathogen Indicators and Classical Pollutants

A total of 15 grab samples were collected for analysis of the three pathogen indicators over the five 24-hour sampling periods (results and collection times for each grab sample are presented in Appendix A-1). Pathogen indicators generally were not detected in the effluent from the treatment system; the exceptions to this were 3 grab samples, with fecal coliform detected at concentrations close to the detection limit on Days 1 and 2, and *E. coli* detected at 6.30 MPN/100 mL on Day 5 (detection limit is 1 MPN/100 mL).

Eleven of the 15 classical pollutants were detected in effluent from graywater treatment system; 4 classical pollutants (HEM, settleable residue, SGT-HEM, and TSS) were not detected in any effluent samples. Only one of the 11 detected classical analytes–hardness–was detected at some level in the equipment blank (flagged by an "e" in Table 4-4; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of this analyte to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Seven of the detected analytes were also detected at some level in the potable water used as source water for all graywater and sewage systems (flagged by an "s" in Table 4-4; see Table 4-14 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples. Note that anomalous analytical results were obtained for ammonia; these results are presented and discussed in Section 5.1.2.

Chart 4 shows that classical pollutant concentrations in the graywater effluent from the Oosterdam graywater treatment system are lower than EPA's standards for secondary treatment.

Chart 4. Classical Pollutant Comparison of Effluent from Oosterdam Graywater Treatment System to Secondary Treatment Standards

Classical Pollutant	Average Effluent from Oosterdam Graywater Treatment System	Secondary Treatment Standards (a)
Biochemical Oxygen Demand (BOD_5)	28.1 mg/L	45 mg/L
Total Suspended Solids (TSS)	ND(5.00) mg/L	45 mg/L

(a) 40 CFR 133.102 Secondary Treatment Regulations, 7-day average.
ND - Not detected (number in parentheses is detection limit).

Total and Dissolved Metals

Among the 54 total and dissolved metal analytes, 27 were detected in one or more effluent from treatment samples (Table 4-4). Of these 27 detected metals analytes, 15 were detected in every effluent from treatment sample. Twelve of the 27 detected analytes were also detected at some level in the equipment blank (flagged by an "e" in Table 4-4; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of these analytes to the samples. EPA will consider the impact of contamination from

equipment in a future analysis. Twenty of these detected analytes were also detected at some level in the potable water used as source water for all graywater systems (flagged by an "s" in Table 4-4; see Table 4-14 for source water results), meaning that the source water may have contributed some or all these analytes to the samples.

The ten metal analytes detected at the highest concentrations were total and dissolved calcium, magnesium, iron, sodium, and zinc. Total and dissolved zinc and copper, and total nickel are priority pollutant metals (designated by EPA in 40 CFR Part 423, Appendix A) that were detected in every effluent from treatment sample. Some metals may result from contact with carbon steel and stainless steel pipes and tanks in the ship. There are no EPA secondary treatment standards for metals.

Semivolatile and Volatile Organics, Pesticides, PCBs, and Dioxin and Furans

Among the 80 target analytes for volatile and semivolatile organics analyzed, only one–phenol– was detected in any Oosterdam graywater effluent samples (Table 4-4). Phenol was detected in the Oosterdam graywater effluent at an average concentration of 67.0 µg/L. Phenol was detected in the source water (flagged by an "s" in Table 4-4; see Table 4-14 for source water results) at a concentration of 58.0 µg/L, meaning that the source water may have contributed some or all of the detected phenol to the effluent samples.

Pesticides, PCBs, and dioxins and furans were not analyzed for in the effluent from the graywater treatment system.

4.1.5 Wastewater Treatment System Performance: Comparison of Influent to Graywater Treatment System and Effluent from Graywater Treatment System

The ROCHEM graywater treatment system successfully removed almost all pathogen indicators (>99%; Table 4-5), and most classical pollutants and metals (Table 4-6).

Pathogen Indicators and Classical Pollutants

Pathogen indicators were substantially removed by reverse osmosis (>99%); any remaining pathogen indicators were generally removed by UV disinfection to levels below detection (overall system efficiency >99%, see Table 4-5). Enterococci was not detected in any of the 15 effluent from treatment samples. Fecal coliform was detected in 2 of the 15 samples at levels close to the detection limit, and *E. coli* was detected 1 of the 15 samples at a level of 6.30 MPN/100mL.

The graywater treatment system removed most biochemical oxygen demand (BOD_5) (80%), chemical oxygen demand (COD) (85%), and total organic carbon (TOC) (70%) (Table 4-6). The system also removed all settleable residue, HEM/SGT-HEM, and total suspended solids (TSS) to levels below detection.

The treatment system reduced total Kjeldahl nitrogen (TKN, which measures both ammonia and organic forms of nitrogen) by 76%, while the removal of nitrate/nitrite was 44%. Total phosphorus was removed by 90%. TKN, nitrate/nitrite, and total phosphorus were likely removed from the graywater treatment system via the reverse osmosis concentrate as the graywater treatment system has no mechanism for biodegradation. Ammonia results for this sampling episode were anomalous; therefore, EPA is unable to assess the performance of the graywater treatment system for this analyte at this time. During the 2005 cruise season, EPA conducted a supplementary sampling program to collect treatment performance data for ammonia (see Section 5.1.2).

Total and Dissolved Metals

The total metals analysis measures both the particulate and dissolved forms of metals, while the dissolved metals analysis measures only the dissolved form. The difference between the total and dissolved metals measurements is the particulate metals concentration. Metals were present in both particulate and dissolved forms in the influent to the graywater treatment system (i.e., the total metals concentrations exceeded the dissolved metals

concentrations for most metals analytes) (Table 4-2). In comparison, metals were predominantly present in the dissolved form in the effluent from the graywater treatment system (i.e., the total and dissolved metals concentrations were similar in these samples for most metal analytes (Table 4-4). This means that the graywater treatment system is highly efficient in removing particulate metals, as would be expected for reverse osmosis (and as supported by removal of settleable residue and TSS to levels below detection). The treatment system removed dissolved metals with an average efficiency of 52% (Table 4-11).

Semivolatile and Volatile Organics, Pesticides, PCBs, Dioxin and Furans

Among the four volatile and semivolatile analytes detected in the influent to the graywater treatment system, none showed significant removals. For bis-(2-ethylhexyl) phthalate and diethyl phthalate, the detection limits in the effluent from graywater treatment samples exceed the average detected concentrations in the influent samples. Toluene was reduced from levels close to the detection limit to less than the detection limit. Phenol concentrations were not reduced by the graywater treatment system.

Pesticides, PCBs, and dioxins and furans were not analyzed for in either the influent to or effluent from the graywater treatment system; EPA has no data regarding the performance of the ROCHEM graywater treatment system for removing these analytes.

4.1.6 Influent to Sewage/Graywater Treatment System

Table 4-7 presents analytical results for the influent to the sewage/graywater treatment system, which was sampled for five consecutive 24-hour sampling periods. Only those analytes detected at least once in any of the wastewater samples (i.e., graywater sources, influents to treatment systems, or effluents from treatment systems) are included in this table. Appendices A-1 and A-2 present results for both detected and nondetected analytes.

Pathogen Indicators and Classical Pollutants

All 3 pathogen indicators and all 15 classical pollutants were detected in the influent to treatment samples. One of these 18 analytes (hardness) was also detected at some level in the equipment blank (flagged by an "e" in Table 4-7; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of this analyte to the samples. EPA will consider the impact of contamination from equipment in a future analysis. Seven of these detected analytes were also detected at some level in the potable water used as source water for all graywater and sewage systems (flagged by an "s" in Table 4-7; see Table 4-14 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples. Note that anomalous analytical results were obtained for ammonia; these results are presented and discussed in Section 5.1.2.

Wastewater conservation practices used onboard, such as use of vacuum toilets, results in highly concentrated wastewater. In addition, sources that would serve to dilute the influent to treatment, such as accommodations wastewater, are not routed to the sewage/ graywater treatment system. Chart 5 compares the influent to the Oosterdam sewage/graywater treatment system to typical domestic wastewater for selected pathogen indicators and classical pollutants. Fecal coliform and enterococci concentrations in the influent to the Oosterdam sewage/graywater treatment system were two or more orders of magnitude greater than in typical untreated domestic wastewater. Key analytes commonly used to assess wastewater strength, such as BOD_5, TSS, and COD, were detected at concentrations two or more times greater than typical domestic wastewater.

Chart 5. Comparison of Influent to Oosterdam Sewage/Graywater Treatment System to Untreated Domestic Wastewater

Analyte	Influent to Oosterdam Sewage/Graywater Treatment System	Untreated Domestic Wastewater (a)
Enterococci	10^5 to 10^6 MPN/100 mL	10^2 to 10^3 number/100 mL
Fecal Coliform	10^6 to 10^7 CFU/100mL	10^4 to 10^5 number/100 mL
Biochemical Oxygen Demand (BOD_5)	690 to 1,380 mg/L	110 to 400 mg/L
Chemical Oxygen Demand (COD)	1,800 to 2,830 mg/L	250 to 1,000 mg/L
Nitrate/Nitrite	0.0160 to 0.0370 mg/L	0 mg/L
Oil and Grease	48.0 to 85.0 mg/L	50 to 150 mg/L
Total Phosphorus	20.9 to 31.8 mg/L	4 to 15 mg/L
Total Suspended Solids (TSS)	560 to 1,110 mg/L	100 to 350 mg/L

(a) Source: Metcalf & Eddy, *Wastewater Engineering*, Third Edition, 1991.

Total and Dissolved Metals

Of the 40 metal analytes detected in the influent to treatment samples, 32 were detected in every influent to sewage/graywater treatment sample (see Table 4-7 for the metals analytical results). Twelve of these 40 analytes were detected at some level in the equipment blank (flagged by an "e" in Table 4-7; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of these analytes to the samples. EPA will consider the impact of contamination from equipment in a future analysis. Twenty of these detected analytes were also detected at some level in the potable water used as source water for all graywater and sewage systems (flagged by an "s" in Table 4-7; see Table 4-14 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples.

The 10 metals detected at the highest concentrations were: total and dissolved sodium, calcium, magnesium, and iron, and total zinc and aluminum. Total and dissolved chromium, copper, lead, nickel, and zinc, and total mercury and silver are priority pollutant metals (designated by EPA in CFR Part 423, Appendix A) that were detected in every influent to treatment sample. Some metals may result from contact with carbon steel and stainless steel pipe and tanks in the ship.

Semivolatile and Volatile Organics, Pesticides, PCBs

Among the 360 target analytes for volatile and semivolatile organics, pesticides, and polychlorinated biphenyls (PCBs), 20 were detected in Oosterdam influent to sewage/graywater treatment samples: 17 PCBs and three semivolatile and volatile organics. Many of these analytes were detected at concentrations close to their detection limits. Phenol was detected in the equipment blank (see Table 5-3 for equipment blank results) (volatile organics were not analyzed for in the equipment blank). EPA will consider the impact of possible contamination from sampling equipment in a future analysis.

The two semivolatile organics detected in the influent to sewage/graywater treatment: bis(2-ethylhexyl) phthalate and phenol. Bis(2-ethylhexyl)phthalate is a plasticizer (a chemical added to plastics to make them flexible) and is commonly detected in environmental samples (ATSDR, 2002). Cruise ships use a wide variety of plastic products (e.g., floor tiles, shower curtains, hoses, packaging materials and containers, PVC piping) that may result in the presence of bis(2-ethylhexyl)phthalate in the influent to treatment.

Phenol is both man-made chemical and produced naturally. It is found in human wastes (urine). It is also found in some foods (smoked summer sausage, fried chicken, mountain cheese, some species of fish). Man-made sources include the use of phenol as a slimicide, as a disinfectant, and in medicinal preparations such as ointments, ear and nose drops, and antiseptic wipes (ATSDR, 1998). All of these are possible sources for the presence of phenol in cruise ship wastewater. Phenol was also detected in the source water (see Table 4-14 for source water results), meaning that the source water may have contributed some or all of this analyte to the samples.

The one volatile organic detected in the influent to treatment was toluene. Toluene occurs naturally in crude oil and is used to produce gasoline, other fuels, and coal. It is also used to make paints, paint thinners, fingernail polish, adhesives, and rubber (ATSDR 2001).

No pesticides were detected in the influent to the Oosterdam sewage/graywater treatment system.

Seventeen PCB congeners and co-eluting congener groups were detected in the influent to the sewage/graywater wastewater treatment system. Total PCBs in the influent were measured at a concentration of 11,400 pg/L. One of the detected PCBs was identified as "toxic" by the World Health Organization: PCB 180 (PCB-180+PCB-193, 620 pg/L). PCBs have traditionally been associated with electrical equipment, such as transformers; however, they have also been used in paint formulations, carbonless copy paper and plastics (EPA, 2005). None of the detected PCBs have any known manufacturers. (Note that PCBs were not analyzed for in the source water.)

4.1.7 Influent to the Ultraviolet (UV) Disinfection Part of the Sewage/Graywater Treatment System

Table 4-8 presents pathogen indicator results for the influent to UV disinfection part of the Oosterdam sewage/graywater treatment system. Grab samples for pathogen indicator analyses were collected at this sampling point for five consecutive 24-hour sampling periods. Pathogen indicators, which were generally in the millions at the influent to the treatment system (see Table 4-7), were reduced to the hundreds after the bioreactor and membrane filter (i.e., before the UV disinfection step). Data for pathogen indicators in the final effluent (i.e., after the UV disinfection step) are presented in the next section.

4.1.8 Effluent from the Sewage/Graywater Treatment System

Table 4-9 presents analytical results for the effluent from the sewage/graywater treatment system, which was sampled for five consecutive 24-hour sampling periods. Only those analytes detected at least once in any of the wastewater samples (i.e., graywater sources, influents to treatment systems, or effluents from treatment systems) are included in this table. Appendices A-1 and A-2 present results for both detected and nondetected analytes.

Pathogen Indicators and Classical Pollutants

A total of 15 grab samples were collected for analysis of the three pathogen indicators over the five 24-hour sampling periods (results and collection times for each grab sample are presented in Appendix A-1). Pathogen indicators generally were not detected in the effluent from the treatment system. Exceptions are enterococci detected in 4 of the 15 samples and *E. coli* detected in 1 of the 15 samples. Most detections were close to the detection limit; however, the second grab sample collected on Day 5 contained enterococci and *E. coli* at 184 and 13.2 MPN/100mL, respectively (detection limit is 1 MPN/100 mL).

Eleven of the 15 classical pollutants were detected in effluent from treatment system; 4 classical pollutants (HEM, settleable residue, SGT-HEM, and TSS) were not detected in any effluent samples. Only one of the 11 detected classical analytes–hardness–was detected at some level in the equipment blank (flagged by an "e" in Table 4-9; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of this analyte to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Seven of the 11 detected classical analytes were also detected at some level in the potable water used as source water for all graywater and sewage systems (flagged by an "s" in Table 4-9; see Table 4-14 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples. Note that anomalous analytical results were obtained for ammonia; these results are presented and discussed in Section 5.1.2.

Chart 6 shows that classical pollutant concentrations in the sewage/graywater effluent from the Oosterdam sewage/graywater treatment system are lower than EPA's standards for secondary treatment.

Chart 6. Classical Pollutant Comparison of Effluent from Oosterdam Sewage/Graywater Treatment System to Secondary Treatment Standards

Classical Pollutant	Average Effluent from Oosterdam Sewage/Graywater Treatment System	Secondary Treatment Standards(a)
Biochemical Oxygen Demand (BOD_5)	4.22 mg/L	45 mg/L
Total Suspended Solids (TSS)	ND(5.00) mg/L	45 mg/L

(a) 40 CFR 133.102 Secondary Treatment Regulations, 7-day average.
(b) ND - Not detected (number in parentheses is detection limit).

Total and Dissolved Metals

Among the 54 total and dissolved metals analytes tested for, 32 were detected in one or more effluent from treatment samples (Table 4-9). Of these 32 detected metals analytes, 24 were detected in every effluent from treatment sample. Thirteen of the 32 detected metal analytes were also detected at some level in the equipment blank (flagged by an "e" in Table 4-9; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of these analytes to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Twenty of these detected metal analytes were also detected at some level in the potable water used as source water for all graywater systems (flagged by an "s" in Table 4-9; see Table 4-14 for source water results), meaning that the source water may have contributed some or all these analytes to the samples.

The ten metal analytes detected at the highest concentrations were total dissolved calcium, magnesium, iron, sodium, and zinc. Total and dissolved zinc, nickel, lead, chromium, and copper are priority pollutant metals (designated by EPA in 40 CFR Part 423, Appendix A) that were detected in every effluent from treatment sample. Some metals may result from contact with carbon steel and stainless steel pipes and tanks in the ship. There are no EPA secondary treatment standards for metals.

Semivolatile and Volatile Organics, Pesticides, PCBs, Dioxins and Furans

Among the 80 target analytes for volatile and semivolatile organics analyzed, only one–phenol– was detected in any Oosterdam sewage/graywater effluent samples (Table 4-9). Phenol was detected in the Oosterdam sewage/graywater effluent at an average concentration of 63.4 μg/L. Phenol was detected in the source water (flagged by an "s" in Table 4-9; see Table 4-14 for source water results) at a concentration of 58.0 μg/L, meaning that the source water may have contributed some or all of the detected phenol to the effluent samples.

Pesticides, PCBs, and dioxins and furans were not analyzed for in the effluent from the sewage/graywater treatment system.

4.1.9 Wastewater Treatment System Performance: Comparison of Influent to Sewage/Graywater Treatment System and Effluent from Sewage/Graywater Treatment System

The ROCHEM sewage/graywater treatment system successfully removed most pathogen indicators (>99%; Table 4-10), and most classical pollutants, metals, and organics (Table 4-11).

Pathogen Indicators and Classical Pollutants

Pathogen indicators were substantially removed by the bioreactor and membrane filter (>99%); any remaining pathogen indicators were generally removed by UV disinfection to levels below detection (overall system efficiency >99%, see Table 4-10). Fecal coliform was not detected in any of the 15 effluent from treatment samples. Enterococci was detected in 4 of the 15 samples, and *E. coli* was detected in 1 of the 15 samples. Most detections were close to the detection limit; however, the second grab sample on Day 5 contained enterococci and *E. coli* at 184 and 13.2 MPN/100mL, respectively (the detection limit 1 MPN/100 mL).

The sewage/graywater treatment system removed most biochemical oxygen demand ($BOD_{5)}$ (>99 %), chemical oxygen demand (COD) (95 %) and total organic carbon

(TOC) (86 %) (Table 4-11). The system also removed settleable residue, HEM/SGT-HEM, and total suspended solids (TSS) to levels below detection.

The treatment system reduced total Kjeldahl nitrogen (TKN, which measures both ammonia and organic forms of nitrogen) by 70%, while nitrate/nitrite levels remained relatively unchanged (Table 4-11). Total phosphorus was removed by 41%. Nitrogen and phosphorus are likely taken up by the microorganisms in the bioreactor and removed from the system in the waste biosludge, as evidenced by elevated TKN and total phosphorus concentrations in the waste biosludge (see Section 4.1.11 and Table 4-13). It is unlikely that nitrogen is removed by nitrification (the mechanism of ammonia biodegradation) as nitrification would have resulted in significant increases in nitrate/nitrite concentrations, but these levels remained relatively unchanged. Ammonia results for this sampling episode were anomalous; therefore, EPA is unable to assess the performance of the sewage/graywater treatment system for this analyte at this time. During the 2005 cruise season, EPA conducted a supplementary sampling program to collect additional performance data for ammonia (see Section 5.1.2).

Total and Dissolved Metals

The total metals analysis measures both the particulate and dissolved forms of metals, while the dissolved metals analysis measures only the dissolved form. The difference between the total and dissolved metals measurements is the particulate metals concentration. Metals were present in both particulate and dissolved forms in the influent to the sewage/ graywater treatment system (i.e., the total metals concentrations exceeded the dissolved metals concentrations for most metals analytes) (Table 4-7). In comparison, metals were predominantly present in the dissolved form in the effluent from the sewage/graywater treatment system (i.e., the total and dissolved metals concentrations were similar in these samples for most metals analytes) (Table 4-9). Furthermore, there were elevated metals concentrations in the screening solids and waste biosludge (see Table 4-13). This means that the treatment system is highly efficient in removing particulate metals, as would be expected for membrane filtration (and as supported by >99% removal of settleable residue and TSS, see Table 4-11). The treatment system removed dissolved metals with an average efficiency of 40% (Table 4-11).

Semivolatile and Volatile Organics, Pesticides, PCBs, Dioxins and Furans

The sewage/graywater treatment system removed bis(2-ethylhexyl)phthalate and toluene to levels below detection, and removed phenol by 33%. Possible removal mechanisms include biological degradation, adsorption onto screening solids and waste biosludge (Table 4-13), and/or volatilization.

Pesticides were not detected in the influent to sewage/graywater treatment and were not analyzed for in the effluent from sewage/graywater treatment. While PCBs were detected in the influent to treatment at low levels, they were not analyzed for in the effluent from sewage/graywater treatment; EPA has no data regarding the performance of the ROCHEM sewage/graywater treatment system for removing PCBs. Dioxin and furans were not analyzed for in either the influent to or effluent from the sewage/graywater treatment system. Dioxins and furans were analyzed for in laundry wastewater, and none were detected.

4.1.10 Final Combined Treated Effluent from Graywater and Sewage/Graywater Treatment Systems

Table 4-12 presents analytical results for the final combined discharge from the graywater and sewage/graywater treatment systems (final combined treated effluent), which was sampled for five consecutive 24-hour sampling periods. Only those analytes detected at least once in any of the wastewater samples (i.e., graywater sources, influents to treatment systems, or effluents from treatment systems) are included in this table. Appendices A-1 and A-2 present results for both detected and nondetected analytes.

Pathogen Indicators and Classical Pollutants

A total of 14 grab samples were collected for analyses of the three pathogen indicators over the five 24-hour sampling periods (results and collection times for each grab sample are presented in Appendix A-1). Pathogen indicators generally were not detected in the final combined treated effluent. Exceptions are *E. coli* detected in 2 of 14 samples, enterococci detected in 3 of 14 samples, and fecal coliform detected in 2 of 14 samples. Most detections were close to the detection limit; however, the second grab sample collected on Day 1 contained *E. coli* at 49.6 MPN/100mL (detection limit is 1 MPN/100mL).

Eleven of the 15 classical pollutants were detected in the final combined effluent; four classical pollutants (HEM, settleable residue, SGT-HEM, and TSS) were not detected in any effluent samples. Only one of the 11 detected analytes–hardness–was detected at some level in the equipment blank (flagged by an "e" in Table 4-12; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of this analyte to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Seven of these detected analytes were also detected at some level in the potable water used as source water for all graywater and sewage systems (flagged by an "s" in Table 4-12; see Table 4-14 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples.

Chart 7 shows that classical pollutant concentrations in the final combined effluent from the Oosterdam graywater and sewage/graywater treatment systems are lower than EPA's standards for secondary treatment.

Chart 7. Classical Pollutant Comparison of Final Combined Effluent from the Oosterdam Graywater and Sewage/Graywater Treatment Systems to Secondary Treatment Standards

Classical Pollutant	Average Final Combined Treated Effluent	Secondary Treatment Standards(a)
Biochemical Oxygen Demand (BOD_5)	17.6 mg/L	45 mg/L
Total Suspended Solids (TSS)	ND(5.00) mg/L	45 mg/L

(a) 40 CFR 133.102 Secondary Treatment Regulations, 7-day average.
(b) ND - Not detected (number in parentheses is detection limit).

Total and Dissolved Metals

Among the 54 total and dissolved metals analytes, 29 were detected in one or more Final Combined Discharge from treatment samples (Table 4-12). Of these 29 detected metals analytes, 19 were detected in every effluent from treatment sample. Twelve of the 29 detected analytes were also detected at some level in the equipment blank (flagged by an "e" in Table 4-12; see Table 5-3 for equipment blank results), meaning that the sampling equipment may have contributed some or all of these analytes to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Twenty of these detected analytes were also detected at some level in the potable water used as source water for all graywater systems (flagged by an "s" in Table 4-12; see Table 4-14 for source water results), meaning that the source water may have contributed some or all these analytes to the samples.

The 10 metal analytes detected at the highest concentrations were total and dissolved calcium, magnesium, iron, sodium, and zinc. Total and dissolved zinc, nickel, and copper, and dissolved chromium are priority pollutant metals (designated by EPA in 40 CFR Part 423, Appendix A) that were detected in every effluent from treatment sample. Some metals may result from contact with carbon steel and stainless steel pipes and tanks in the ship. There are no EPA secondary treatment standards for metals.

Semivolatile and Volatile Organics, Pesticides, PCBs, Dioxins and Furans

Among the 80 target analytes for volatile and semivolatile organics analyzed, only one-phenol- was detected in any Oosterdam final combined treated effluent samples (Table 4-12). Phenol was detected in the combined Oosterdam effluent at an average concentration of 53 μg/L. Phenol was detected in the source water (flagged by an "s" in Table 4-12; see Table 4-14 for source water results) at a concentration of 58.0 μg/L, meaning that the source water may have contributed some or all of the detected phenol to the effluent samples.

Pesticides, PCBs, and dioxins and furans were not analyzed for in the final combined effluent from the treatment systems.

4.1.11 Screening Solids, Waste Biosludge, and Incinerator Ash

Table 4-13 presents the results for analytes detected in one-time grab samples of graywater screening solids, sewage/graywater screening solids, sewage/graywater waste biosludge (extra biological mass from the treatment system's bioreactor), and incinerator ash (from incineration of trash, including food solids from the food pulper, ROCHEM sewage/graywater treatment system screening solids, and spent bag filters) collected during the sampling episode. Table 4-13 also shows the average influents to the graywater and sewage/ graywater treatment systems analyte concentrations from Tables 4-2 and 4-7 for comparison.

Most of the analytes detected in the screening solids and waste biosludge were also detected in the influents to the treatment systems. For many analytes, concentrations in the screening solids and waste biosludge exceeded those in the influents to the treatment systems, suggesting that these analytes are removed from the systems in these waste streams. See Sections 4.1.5 and 4.1.9 for a detailed discussions of wastewater treatment system performance.

4.1.12 Source Water

Potable water is used as source water for all ship operations that generate graywater and sewage (e.g., laundry, galley, food pulper, sinks, showers, and toilets). Potable water is produced onboard and seldom bunkered while in port. Ten total metals, 10 dissolved metals, 7 classical pollutants, and 2 volatile and semivolatile organics were detected in the one-time grab sample of potable water collected during this sampling episode (Table 4-14). None of the analytes detected in the source water exceeded Federal drinking water standards (Table 4-14). Pathogen indicators were not detected in the source water sample.

4.2 Summary of Interviews Regarding Activities that Impact Wastewater Generation

The ship's crew was interviewed to obtain information regarding activities that impact wastewater generation (see Appendix C for detailed reports). The ship's crew provided operational, discharge, and wastewater treatment operating logs corresponding to the period of the sampling episode. These documents are included in the Cruise Ship Rulemaking Record and are available upon request.

4.2.1 Wastewater Generation

Galley

The Oosterdam has three dining rooms and 24-hour room service. Approximately 9,000 total meals (breakfast, lunch, dinner, snacks) are served daily. Initial preparation of fish, pork, and beef are performed on Deck A, while cooking occurs in the galleys (two passenger galleys and one crew galley). The ship galleys are equipped with twelve dishwashers in total, including six large and six smaller machines. Dishwashers operate each day from the start of meal sittings until 3 ½ - 4 hours after each meal sitting (breakfast, lunch, and dinner). Dishes are washed using Solid Power and Rinse Dry, which are dispensed automatically to each machine. The Oosterdam also uses Solitaire and Solid Metal Pro, for washing hands, pots, and pans; Bioclean for cleaning hoods and sinks; Absorbit for cleaning floors; Grill Shine (a lemon juice extract) for cleaning galley grills; and Hepburn Bio WC Clean for cleaning floor drains. All cleaning agents are listed on Holland American Cruise Line's approved chemicals list (ACL). Material Safety Data Sheets (MSDS) for these products are included in the Cruise Ship Rulemaking Record and are available upon request.

Laundry

The main Oosterdam laundry operates 15 hours per day between the hours of 0900 and 2400. It has a total of seven washers and six driers. Three large washers process approximately eight loads of towels (400 lb per load) per day, and two medium washers process

one or more loads of passenger clothing (125 lb per load) per day. Two small washers process 20 loads (15 lb per load) per day. The crew laundry contains 15 launderette machines. All laundry and laundrette machines include auto-dispense of cleaning agents listed on the ACL. Laundry cleaning agents include: Diverdet 2A, Emphasize, Launch, Liquid Diveralk 1C, Renew Extra, Super Impede, and Valid II. MSDS for these products are included in the Cruise Ship Rulemaking Record and are available upon request.

Photo Processing

The Oosterdam has a photo processing lab. All waste photographic chemicals are collected into drums for disposal onshore. Silver-containing wastes are pretreated by a silver recovery cartridge, which retains the silver within the filter for recovery. There is one primary cartridge and one backup; each provides approximately 600 hours of operation. Use of two digital machines has significantly reduced the volume of chemicals used as compared to analog film machines; however, the chemicals used in digital photo processing machines are more concentrated. A laboratory sink is used to rinse equipment such as chemical trays. The sink is physically blocked to prohibit discharges to the graywater CHT system, and collected rinse waters are pumped to the silver recovery cartridges. Two floor drains in the photo lab are blocked to ensure spilled chemicals do not enter the drain system.

Print Shop

The Oosterdam houses an onboard print shop, with one offset printer, three copiers, and one laser printer. Wastes, such as rags and residual chemicals, are disposed of onshore as hazardous waste. Spent toner cartridges are recycled through onshore vendors. Two print shop sinks are used for hand washing only and are plumbed to the accommodations CHT system. The shop has an open floor drain; the ship's crew indicated no chemical spills to date. Cleaning solvents and offset printing chemicals (alcohol, deglazer, plate etch) are stored in a locked cabinet.

Dry Cleaning

The Oosterdam has a dry cleaning facility with one dry cleaning machine and one small spot-cleaning machine. The dry cleaning machine is self-contained, with perchloroethylene distilled and recycled. Dry cleaning condensate and other solvent wastes and sludge (approximately 20L per month) are disposed of onshore as hazardous waste; no solvent wastes or wastewaters enter the graywater CHT system.

Chemical Storage

Any spills from the engine room storage areas are captured in the bilge and do not enter the graywater or sewage systems. See Appendix C for more information on chemicals stored in each engine room. Chemicals are also stored in other rooms of the ship as listed in Appendix C; these storage rooms have no floor drains to ensure that spilled chemicals do not enter the graywater and sewage systems.

Medical Infirmary/Dental Care

The Oosterdam provides onboard medical and dental care. Wastes such as machine cleaning chemical residuals, rags, outdated medications, and screened residual amalgam are disposed of onshore. Sinks and floor drains in the pantry and sinks in the examining rooms drain to the graywater CHT system. In addition, general cleaning wastewater and wastewater from the autoclave/sanitizing machine and from digital imaging are routed to the graywater CHT system. Sewage from toilets is collected by the sewage CHT systems. Floor drains in the garbage room drain to the bilge for treatment by oil/water separation prior to discharge.

Garbage Room

The Oosterdam has a garbage room onboard. The room is refrigerated, with solid/wet separation and crushing equipment. There is extensive recycling with hand separation of all garbage (e.g., glass, aluminum, tin cans, box board, wet garbage, flourescent tubes, and

batteries). The sink located in the garbage room is for hand washing only. Chemical storage is kept in a hazardous chemical locker with no drains.

4.2.2 Pesticide, Fungicide, and Rodenticide Use

No pesticides, fungicides, or rodenticides are used on the Oosterdam.

4.3 Flow Data

Strap-on ultrasonic flow meters were used to collect flow measurements and, in some cases, to control automatic composite sample machines on: (1) the outlet pipe from one of the accommodations holding tanks, (2) the influent to the graywater treatment system, (3) the effluent from the graywater treatment system, (4) the influent to the sewage/graywater treatment system, (5) the effluent from the sewage/graywater treatment system, and (6) the final combined effluent from the graywater and sewage/graywater treatment systems (see Section 2.4 and Figures 2-1 through 2-3). The flow meters were programmed to record instantaneous flow rate (m^3/min) at total flow (m^3) every five minutes. Flow data analyses presented in this section are based on only those flow data collected during the sampling episode of September 18 through September 23. Appendix B presents all flow data collected while onboard the Oosterdam from September 18 through September 23, 2005.

The total daily volume of wastewater from each of the six flow meter locations for each 24-hour sampling period are presented in Figure 4-1. The Oosterdam suspended overboard discharge (final combined treated effluent) for part of Day 1 while in State of Washington waters and for part of Day 4 while the ship cruised Hubbard Glacier. In addition, at the end of Day 3, high pressure caused the installed flow meter on the effluent to the graywater treatment system to lose signal strength; no flow measurements were collected at this location on Days 4 and 5. With the exception of the final overboard discharge (which was suspended for parts of Day 1 and Day 4), total daily flow at all locations remained relatively constant over the five-day sampling episode, regardless of whether the ship was in port (Day 1, 3, and 5) or at sea (Day 2 and 4).

Daily flow rates and flow per capita are presented in Table 4-15. Per capita flow rates were calculated based on 2,625 people (1,857 passengers and 768 crew) onboard during the sampling episode, as reported by the ship's crew. (Per capita volumes of accommodations wastewater generated were not calculated because the flow for only one collection tank was monitored.) On average, each person generated 31 gallons of untreated accommodations and laundry wastewater and 23 gallons of untreated sewage, galley wastewater, and membrane concentrate generated by the ROCHEM graywater treatment system. Average combined discharge from the graywater and sewage/graywater treatment systems was 45 gallons per person per day.

Figures 4-2 and 4-3 present the average flows for effluent from graywater treatment and effluent from sewage/graywater treatment for each hour interval over the five consecutive 24-hour sampling periods. The effluent flow from the graywater treatment system fluctuates substantially throughout the day. Flow rates were higher during the day and lower at night, as expected because accommodations wastewater composes the majority of influent flow to the treatment system. Laundry wastewater composes the remainder of the influent to the treatment system; the laundry operates from 0900 to 2400. The effluent flow from the sewage/graywater treatment system remains relatively constant throughout the day.

Table 4-1

Graywater Analytical Results, Holland America Oosterdam

Analytical results for each graywater source for analytes detected at least once in wastewater samples during the sampling episode. See Appendices A-1 and A-2 for all analytical results (detected and nondetected). Graywater samples were collected for one 24-hour period; see Section 3.2 for the sample collection methodology. Table 2-1 lists the specific wastewater streams in each graywater source, and Figure 2-1 identifies sampling point locations. Certain food pulper wastewater results were converted from mass to volume units; see Section 3.3. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Laundry (SP-1) (a)	Accommodations (SP-3) (a)	Food Pulper (SP-4) (a)	Galley (SP-5) (a)
Pathogen Indicators						
E. coli	MPN/100 mL		7,700	10,700	100,000	3,880
Enterococci	MPN/100 mL		272	450	1,600,000	2,690
Fecal Coliform	CFU/100 mL		17,000	120,000,000	100,000	1,900
Classical Pollutants						
Alkalinity	mg/L		35.9	ND(20.0)	ND(200)	75.9
Biochemical Oxygen Demand (BOD_5)	mg/L		106	376	50,200	801
Chemical Oxygen Demand (COD) (s)	mg/L		323	1,730	25,300	1,740
Chloride (s)	mg/L		13.0	175	2,250	45.0
Hardness (e) (s)	mg/L		2.00	43.3	NC	12.2
Hexane Extractable Material (HEM)	mg/L		9.00	47.0	NC	51.0
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		0.0580	0.100	0.951	0.0270
Settleable Residue	mL/L		ND(0.120)	15.0	1,000	3.40
Silica Gel Treated HEM (SGT-HEM)	mg/L		ND(6.00)	ND(6.00)	NC	ND(6.00)
Sulfate (s)	mg/L		3.22	103	612	108
Total Dissolved Solids (TDS)	mg/L		93.0	379	NC	631
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		3.27	34.1	362	40.6
Total Organic Carbon (TOC) (s)	mg/L		69.1	79.7	77,500	298
Total Phosphorus	mg/L		0.380	2.31	371	10.6

(a) Sampling point location; see Figure 2-1.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).

Table 4-1 (Continued)

Analyte	Unit	Priority Pollutant Code	Laundry (SP-1) (a)	Accommodations (SP-3) (a)	Food Pulper (SP-4) (a)	Galley (SP-5) (a)
Total Suspended Solids (TSS)	mg/L		24.0	430	NC	564
Total and Dissolved Metals						
Aluminum, Total	ug/L		1,270	1,400	3.92	178
Arsenic, Total	ug/L	P115	ND(2.00)	ND(2.00)	ND(0.0411)	2.89
Barium, Total (e) (s)	ug/L		12.7	292	1.14	222
Boron, Total	ug/L		148	232	ND(0.0630)	180
Cadmium, Total	ug/L	P118	ND(0.0800)	0.880	0.0151	ND(0.0800)
Calcium, Total (e) (s)	ug/L		457	4,800	630	2,580
Chromium, Total	ug/L	P119	ND(0.270)	77.1	0.532	3.53
Cobalt, Total	ug/L		ND(0.660)	0.880	ND(0.00548)	ND(0.660)
Copper, Total (e) (s)	ug/L	P120	35.3	988	2.32	417
Iron, Total (e) (s)	ug/L		117	2,570	112	579
Lead, Total (e) (s)	ug/L	P122	ND(0.620)	ND(0.620)	0.103	63.8
Magnesium, Total (s)	ug/L		209	7,610	105	1,400
Manganese, Total (e) (s)	ug/L		3.34	33.8	5.22	22.3
Mercury, Total	ug/L	P123	ND(0.0500)	0.130	ND(0.00274)	ND(0.0500)
Molybdenum, Total	ug/L		ND(1.60)	4.04	0.0562	ND(1.60)
Nickel, Total (s)	ug/L	P124	3.09	85.8	0.285	47.2
Selenium, Total	ug/L	P125	ND(1.40)	ND(1.40)	0.110	ND(1.40)
Silver, Total	ug/L	P126	ND(0.770)	4.96	ND(0.0151)	ND(0.770)
Sodium, Total (s)	ug/L		19,400	153,000	1,050	58,800
Tin, Total	ug/L		ND(0.940)	14.3	ND(0.0493)	2.10
Titanium, Total	ug/L		1.59	14.9	0.210	2.17
Vanadium, Total	ug/L		ND(0.470)	4.19	ND(0.0137)	ND(0.470)
Zinc, Total (e) (s)	ug/L	P128	151	10,100	3.22	3,260

(a) Sampling point location; see Figure 2-1.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).

Table 4-1 (Continued)

Analyte	Unit	Priority Pollutant Code	Laundry (SP-1) (a)	Accommodations (SP-3) (a)	Food Pulper (SP-4) (a)	Galley (SP-5) (a)
Aluminum, Dissolved	ug/L		317	202	NC	108
Antimony, Dissolved	ug/L	P114	ND(2.00)	ND(2.00)	NC	ND(2.00)
Arsenic, Dissolved	ug/L	P115	ND(2.00)	ND(2.00)	NC	3.37
Barium, Dissolved (e) (s)	ug/L		0.990	191	NC	127
Beryllium, Dissolved	ug/L	P117	0.0800	ND(0.0700)	NC	ND(0.0700)
Boron, Dissolved (e)	ug/L		108	258	NC	244
Cadmium, Dissolved (e)	ug/L	P118	0.240	ND(0.0800)	NC	0.0850
Calcium, Dissolved (s)	ug/L		318	4,020	NC	2,190
Chromium, Dissolved	ug/L	P119	0.980	0.890	NC	1.43
Cobalt, Dissolved (s)	ug/L		1.90	2.37	NC	1.96
Copper, Dissolved (s)	ug/L	P120	35.6	26.3	NC	335
Iron, Dissolved (e)	ug/L		94.8	1,120	NC	332
Lead, Dissolved (e) (s)	ug/L	P122	2.36	2.04	NC	30.7
Magnesium, Dissolved (s)	ug/L		230	7,050	NC	1,350
Manganese, Dissolved (s)	ug/L		5.29	23.4	NC	21.3
Mercury, Dissolved	ug/L	P123	ND(0.0500)	ND(0.0500)	NC	ND(0.0500)
Nickel, Dissolved (s)	ug/L	P124	4.46	28.2	NC	49.1
Silver, Dissolved	ug/L	P126	0.960	ND(0.770)	NC	ND(0.770)
Sodium, Dissolved (e) (s)	ug/L		21,800	79,500	NC	66,800
Tin, Dissolved	ug/L		ND(0.940)	ND(0.940)	NC	1.38
Titanium, Dissolved	ug/L		0.720	ND(0.620)	NC	ND(0.620)
Vanadium, Dissolved	ug/L		ND(0.470)	ND(0.470)	NC	ND(0.470)
Zinc, Dissolved (s)	ug/L	P128	82.4	1,910	NC	2,390

(a) Sampling point location; see Figure 2-1.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).

Table 4-1 (Continued)

Analyte	Unit	Priority Pollutant Code	Laundry (SP-1) (a)	Accommodations (SP-3) (a)	Food Pulper (SP-4) (a)	Galley (SP-5) (a)
Volatile and Semivolatile Organics						
4-Chloro-3-methylphenol	ug/L	P022	ND(10.0)	ND(11.0)	ND(233)	33.0
Bis(2-ethylhexyl) phthalate	ug/L	P066	42.0	ND(11.0)	ND(233)	22.0
Chloroform (s)	ug/L	P023	6.00	5.12	ND(0.685)	ND(5.00)
Diethyl phthalate	ug/L	P070	ND(10.0)	ND(11.0)	ND(233)	ND(10.0)
Phenol (e) (s)	ug/L	P065	52.0	62.0	ND(233)	64.0
Toluene	ug/L	P086	ND(5.00)	87.0	ND(0.685)	ND(5.00)

(a) Sampling point location; see Figure 2-1.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).

Table 4-2

Influent to Graywater Treatment System Analytical Results, Holland America Oosterdam

Analytical results for the influent to the graywater treatment system for analytes detected at least once in wastewater samples during the sampling episode. See Appendices A-1 and A-2 for all analytical results (detected and nondetected). Influent to graywater treatment system samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for the sample collection methodology. Figure 2-2 identifies sampling point location. Average influent to treatment concentrations determined from the daily results. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Influent to GW Treatment (SP-6) (a) Day 1	Influent to GW Treatment (SP-6) (a) Day 2	Influent to GW Treatment (SP-6) (a) Day 3	Influent to GW Treatment (SP-6) (a) Day 4	Influent to GW Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Pathogen Indicators								
E. coli (b)	MPN/100 mL		37,600 [N=2]	59,400 [N=2]	36,500 [N=2]	55,200 [N=2]	79,400 [N=2]	53,600
Enterococci (b)	MPN/100 mL		> 1,260 [N=2]	201 [N=2]	674 [N=2]	1,420 [N=2]	< 1,800 [N=2]	#1,070
Fecal Coliform (b)	CFU/100 mL		14,200,000 [N=2]	6,450,000 [N=2]	6,550,000 [N=2]	17,000,000 [N=2]	< 65,000,000 [N=2]	<21,800,000
Classical Pollutants								
Alkalinity	mg/L		31.8	43.1	56.4	50.2	35.9	43.5
Biochemical Oxygen Demand (BOD_5)	mg/L		149	132	146	143	145	143
Chemical Oxygen Demand (COD) (s)	mg/L		538	335	403	359	392	405
Chloride (s)	mg/L		13.0	13.0	25.0	25.0	17.0	18.6
Hardness (e) (s)	mg/L		5.39	5.18	5.42	8.88	5.82	6.14
Hexane Extractable Material (HEM)	mg/L		143	37.0	51.0	47.0	43.0	64.2
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		0.0110	0.0160	0.0160	0.120	0.0170	0.0360
Settleable Residue	mL/L		0.530	1.10	0.590	3.00	0.500	1.14

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).
- Average result includes at least one nondetect value (calculation uses detection limits for nondetected results) and at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-2 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to GW Treatment (SP-6) (a) Day 1	Influent to GW Treatment (SP-6) (a) Day 2	Influent to GW Treatment (SP-6) (a) Day 3	Influent to GW Treatment (SP-6) (a) Day 4	Influent to GW Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Silica Gel Treated HEM (SGT-HEM)	mg/L		7.00	ND(6.00)	ND(6.00)	ND(6.00)	ND(6.00)	<6.20
Sulfate (s)	mg/L		11.9	12.0	12.2	10.8	6.91	10.8
Total Dissolved Solids (TDS)	mg/L		86.0	95.0	132	160	64.0	107
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		9.87	0.380	10.2	15.5	9.44	9.08
Total Organic Carbon (TOC) (s)	mg/L		54.7	44.5	60.4	56.3	51.3	53.4
Total Phosphorus	mg/L		1.47	3.94	1.13	1.13	0.850	1.70
Total Suspended Solids (TSS)	mg/L		95.0	73.0	86.0	99.0	93.0	89.2
Total and Dissolved Metals								
Aluminum, Total	ug/L		653	672	702	1,020	673	744
Arsenic, Total	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Total (e) (s)	ug/L		134	134	137	137	135	135
Boron, Total	ug/L		ND(18.0)	ND(18.0)	ND(18.0)	ND(18.0)	74.3	<29.3
Cadmium, Total	ug/L	P118	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)
Calcium, Total (e) (s)	ug/L		1,640	1,570	1,600	1,960	1,640	1,680
Chromium, Total	ug/L	P119	2.76	3.50	3.80	9.52	6.67	5.25
Cobalt, Total	ug/L		ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)
Copper, Total (e) (s)	ug/L	P120	156	289	219	197	204	213
Iron, Total (e) (s)	ug/L		366	339	334	423	406	374
Lead, Total (e) (s)	ug/L	P122	5.41	9.34	7.36	6.91	7.88	7.38

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).
- Average result includes at least one nondetect value (calculation uses detection limits for nondetected results) and at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-2 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to GW Treatment (SP-6) (a) Day 1	Influent to GW Treatment (SP-6) (a) Day 2	Influent to GW Treatment (SP-6) (a) Day 3	Influent to GW Treatment (SP-6) (a) Day 4	Influent to GW Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Magnesium, Total (s)	ug/L		317	305	346	968	417	471
Manganese, Total (e) (s)	ug/L		7.65	6.95	7.61	8.87	8.19	7.85
Mercury, Total	ug/L	P123	ND(0.0500)	ND(0.0500)	ND(0.0500)	0.0550	0.0850	<0.0580
Molybdenum, Total	ug/L		ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)
Nickel, Total (s)	ug/L	P124	14.5	17.7	16.6	18.5	18.3	17.1
Selenium, Total	ug/L	P125	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)
Silver, Total	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	2.27	2.27	<1.37
Sodium, Total (s)	ug/L		16,000	20,300	24,800	26,400	18,800	21,300
Tin, Total	ug/L		ND(0.940)	1.03	ND(0.940)	6.92	2.45	<2.46
Titanium, Total	ug/L		1.47	1.69	1.76	3.51	1.79	2.04
Vanadium, Total	ug/L		0.810	ND(0.470)	0.840	0.890	ND(0.470)	<0.696
Zinc, Total (e) (s)	ug/L	P128	667	598	924	870	895	791
Aluminum, Dissolved	ug/L		279	223	183	209	271	233
Antimony, Dissolved	ug/L	P114	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Arsenic, Dissolved	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Dissolved (e) (s)	ug/L		73.5	40.1	25.9	25.3	78.4	48.6
Beryllium, Dissolved	ug/L	P117	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)
Boron, Dissolved (e)	ug/L		114	95.0	59.0	69.6	ND(18.0)	<71.1
Cadmium, Dissolved (e)	ug/L	P118	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).
- Average result includes at least one nondetect value (calculation uses detection limits for nondetected results) and at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-2 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to GW Treatment (SP-6) (a) Day 1	Influent to GW Treatment (SP-6) (a) Day 2	Influent to GW Treatment (SP-6) (a) Day 3	Influent to GW Treatment (SP-6) (a) Day 4	Influent to GW Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Calcium, Dissolved (s)	ug/L		1,450	1,130	761	1,200	1,630	1,230
Chromium, Dissolved	ug/L	P119	0.390	0.760	0.660	0.640	0.370	0.564
Cobalt, Dissolved (s)	ug/L		2.14	1.72	3.16	3.85	5.11	3.20
Copper, Dissolved (s)	ug/L	P120	70.6	205	100	77.1	92.0	109
Iron, Dissolved (e)	ug/L		199	192	165	179	212	189
Lead, Dissolved (e) (s)	ug/L	P122	1.01	4.47	1.84	1.58	2.20	2.22
Magnesium, Dissolved (s)	ug/L		268	239	234	929	464	427
Manganese, Dissolved (s)	ug/L		9.00	7.30	9.43	11.0	14.9	10.3
Mercury, Dissolved	ug/L	P123	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)
Nickel, Dissolved (s)	ug/L	P124	13.7	15.5	12.7	12.6	14.6	13.8
Silver, Dissolved	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)
Sodium, Dissolved (e) (s)	ug/L		19,100	23,900	23,800	30,700	23,200	24,100
Tin, Dissolved	ug/L		ND(0.940)	ND(0.940)	ND(0.940)	1.04	ND(0.940)	<0.960
Titanium, Dissolved	ug/L		0.920	ND(0.620)	ND(0.620)	ND(0.620)	0.630	<0.682
Vanadium, Dissolved	ug/L		ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)
Zinc, Dissolved (s)	ug/L	P128	130	134	252	160	172	170

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).
- Average result includes at least one nondetect value (calculation uses detection limits for nondetected results) and at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-2 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to GW Treatment (SP-6) (a) Day 1	Influent to GW Treatment (SP-6) (a) Day 2	Influent to GW Treatment (SP-6) (a) Day 3	Influent to GW Treatment (SP-6) (a) Day 4	Influent to GW Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Volatile and Semivolatile Organics								
4-Chloro-3-methylphenol	ug/L	P022	ND(10.0)	ND(10.0)	ND(11.0)	ND(10.0)	ND(12.0)	ND(10.6)
Bis(2-ethylhexyl) phthalate	ug/L	P066	19.0	23.0	ND(11.0)	ND(10.0)	ND(12.0)	<15.0
Chloroform (s)	ug/L	P023	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)
Diethyl phthalate	ug/L	P070	ND(10.0)	14.0	14.0	12.0	12.2	<12.4
Phenol (e) (s)	ug/L	P065	47.0	55.0	62.0	51.0	32.0	49.4
Toluene	ug/L	P086	ND(5.00)	ND(5.00)	ND(5.00)	6.00	ND(5.00)	<5.20

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).
- Average result includes at least one nondetect value (calculation uses detection limits for nondetected results) and at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-3

Influent to Graywater UV Disinfection Analytical Results, Holland America Oosterdam

Analytical results for the influent to UV disinfection part of the graywater treatment system. Influent to UV disinfection samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for the sample collection methodology. Figure 2-2 identifies sampling point location. Average influent to UV concentrations determined from the daily result.

Analyte	Unit	Influent to GW UV (SP-7) (a) Day 1	Influent to GW UV (SP-7) (a) Day 2	Influent to GW UV (SP-7) (a) Day 3	Influent to GW UV (SP-7) (a) Day 4	Influent to GW UV (SP-7) (a) Day 5	Average Influent to GW UV (SP-7) (a)
Pathogen Indicators							
E. coli (b)	MPN/100 mL	< 15.2 [N=3]	72.2 [N=3]	12.2 [N=3]	16.1 [N=3]	< 3.17 [N=3]	<23.8
Enterococci (b)	MPN/100 mL	ND(1.00) [N=3]	< 1.00 [N=3]	ND(1.00) [N=3]	ND(1.00) [N=3]	ND(1.00) [N=3]	<1.00
Fecal Coliform (b)	CFU/100 mL	30,400 [N=3]	2,330 [N=3]	883 [N=3]	1,510 [N=3]	80.3 [N=3]	7,030

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-4

Effluent from Graywater Treatment System Analytical Results, Holland America Oosterdam

Analytical results for the effluent from the graywater treatment system for analytes detected at least once in wastewater samples during the sampling episode. See Appendices A-1 and A-2 for all analytical results (detected and nondetected). Effluent from treatment system samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for the sample collection methodology. Figure 2-2 identifies sampling point location. Average effluent from treatment concentrations determined from the daily results. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Effluent from GW Treatment (SP-8) (a) Day 1	Effluent from GW Treatment (SP-8) (a) Day 2	Effluent from GW Treatment (SP-8) (a) Day 3	Effluent from GW Treatment (SP-8) (a) Day 4	Effluent from GW Treatment (SP-8) (a) Day 5	Average Effluent from GW Treatment (SP-8) (a)
Pathogen Indicators								
E. coli (b)	MPN/100 mL		ND(1.00) [N=3]	ND(1.00) [N=3]	ND(1.00) [N=2]	ND(1.00) [N=3]	< 2.77 [N=3]	<1.35
Enterococci (b)	MPN/100 mL		ND(1.00) [N=3]	ND(1.00) [N=3]	ND(1.00) [N=2]	ND(1.00) [N=3]	ND(1.00) [N=3]	ND(1.00)
Fecal Coliform (b)	CFU/100 mL		< 1.67 [N=3]	< 1.42 [N=3]	ND(2.00) [N=2]	ND(2.00) [N=3]	ND(2.00) [N=3]	<1.82
Classical Pollutants								
Alkalinity	mg/L		23.6	23.6	ND(10.0)	34.9	19.5	<22.3
Biochemical Oxygen Demand (BOD_5)	mg/L		27.9	27.1	24.8	23.2	37.3	28.1
Chemical Oxygen Demand (COD) (s)	mg/L		68.0	56.0	58.0	50.5	79.0	62.3
Chloride (s)	mg/L		8.00	12.0	17.0	17.0	13.0	13.4
Hardness (e) (s)	mg/L		1.17	0.750	0.390	1.30	1.90	1.10
Hexane Extractable Material (HEM)	mg/L		ND(6.00)	ND(6.00)	ND(6.00)	ND(6.00)	ND(6.00)	ND(6.00)
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		ND(0.0100)	ND(0.0100)	0.0270	0.0270	0.0270	<0.0202
Settleable Residue	mL/L		ND(0.110)	ND(0.110)	ND(0.110)	ND(0.110)	ND(0.105)	ND(0.109)
Silica Gel Treated HEM (SGT-HEM)	mg/L		ND(6.00)	ND(6.00)	ND(6.00)	ND(6.00)	ND(6.00)	ND(6.00)
Sulfate (s)	mg/L		2.17	2.70	4.17	2.80	3.43	3.05
Total Dissolved Solids (TDS)	mL/L		ND(10.0)	35.0	53.3	67.0	ND(10.0)	<35.1

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-4 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from GW Treatment (SP-8) (a) Day 1	Effluent from GW Treatment (SP-8) (a) Day 2	Effluent from GW Treatment (SP-8) (a) Day 3	Effluent from GW Treatment (SP-8) (a) Day 4	Effluent from GW Treatment (SP-8) (a) Day 5	Average Effluent from GW Treatment (SP-8) (a)
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		0.120	0.0800	0.470	6.74	3.36	2.15
Total Organic Carbon (TOC) (s)	mg/L		16.5	16.0	12.9	13.4	21.0	15.9
Total Phosphorus	mg/L		0.150	0.120	0.220	0.170	0.220	0.176
Total Suspended Solids (TSS)	mg/L		ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)
Total and Dissolved Metals								
Aluminum, Total	ug/L		ND(8.80)	ND(8.80)	ND(8.80)	28.0	21.8	<15.2
Arsenic, Total	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Total (e) (s)	ug/L		26.8	14.6	11.2	8.60	31.9	18.6
Boron, Total	ug/L		ND(18.0)	ND(18.0)	ND(18.0)	83.0	57.5	<38.9
Cadmium, Total	ug/L	P118	ND(0.0800)	ND(0.0800)	< 0.0867	ND(0.0800)	ND(0.0800)	<0.0813
Calcium, Total (e) (s)	ug/L		352	213	112	164	502	269
Chromium, Total	ug/L	P119	ND(0.270)	ND(0.270)	ND(0.270)	ND(0.270)	ND(0.270)	ND(0.270)
Cobalt, Total	ug/L		ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)
Copper, Total (e) (s)	ug/L	P120	26.8	22.5	167	35.6	97.7	69.9
Iron, Total (e) (s)	ug/L		419	222	469	193	720	405
Lead, Total (e) (s)	ug/L	P122	3.74	ND(0.620)	28.5	2.42	7.21	<8.50
Magnesium, Total (s)	ug/L		70.2	53.3	34.4	216	156	106
Manganese, Total (e) (s)	ug/L		8.18	5.27	81.1	3.77	14.0	22.5
Mercury, Total	ug/L	P123	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)
Molybdenum, Total	ug/L		ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)
Nickel, Total (s)	ug/L	P124	2.64	2.23	2.99	2.81	5.22	3.18

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-4 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from GW Treatment (SP-8) (a) Day 1	Effluent from GW Treatment (SP-8) (a) Day 2	Effluent from GW Treatment (SP-8) (a) Day 3	Effluent from GW Treatment (SP-8) (a) Day 4	Effluent from GW Treatment (SP-8) (a) Day 5	Average Effluent from GW Treatment (SP-8) (a)
Selenium, Total	ug/L	P125	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)
Silver, Total	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)
Sodium, Total (s)	ug/L		12,500	11,900	11,300	20,000	14,200	14,000
Tin, Total	ug/L		ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)
Titanium, Total	ug/L		ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
Vanadium, Total	ug/L		ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)
Zinc, Total (e) (s)	ug/L	P128	236	237	675	196	572	383
Aluminum, Dissolved	ug/L		ND(8.80)	ND(8.80)	< 16.9	ND(8.80)	ND(8.80)	<10.4
Antimony, Dissolved	ug/L	P114	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Arsenic, Dissolved	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Dissolved (e) (s)	ug/L		11.3	5.37	8.06	2.58	21.7	9.80
Beryllium, Dissolved	ug/L	P117	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)
Boron, Dissolved (e)	ug/L		58.4	83.7	73.6	ND(18.0)	ND(18.0)	<50.3
Cadmium, Dissolved (e)	ug/L	P118	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)
Calcium, Dissolved (s)	ug/L		290	256	ND(7.00)	ND(7.00)	478	<208
Chromium, Dissolved	ug/L	P119	ND(0.270)	ND(0.270)	0.440	ND(0.270)	ND(0.270)	<0.304
Cobalt, Dissolved (s)	ug/L		1.26	1.32	ND(0.660)	2.14	3.61	<1.80
Copper, Dissolved (s)	ug/L	P120	4.74	11.7	47.0	2.96	24.9	18.3
Iron, Dissolved (e)	ug/L		190	197	445	103	343	256
Lead, Dissolved (e) (s)	ug/L	P122	2.05	1.89	14.8	ND(0.620)	2.50	<4.37
Magnesium, Dissolved (s)	ug/L		61.6	61.7	ND(6.30)	196	170	<99.1

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-4 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from GW Treatment (SP-8) (a) Day 1	Effluent from GW Treatment (SP-8) (a) Day 2	Effluent from GW Treatment (SP-8) (a) Day 3	Effluent from GW Treatment (SP-8) (a) Day 4	Effluent from GW Treatment (SP-8) (a) Day 5	Average Effluent from GW Treatment (SP-8) (a)
Manganese, Dissolved (s)	ug/L		8.35	7.27	8.15	6.21	14.1	8.82
Mercury, Dissolved	ug/L	P123	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)
Nickel, Dissolved (s)	ug/L	P124	3.10	3.69	4.15	ND(0.310)	5.24	<3.30
Silver, Dissolved	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)
Sodium, Dissolved (e) (s)	ug/L		11,500	14,000	12,100	18,600	14,000	14,000
Tin, Dissolved	ug/L		ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)
Titanium, Dissolved	ug/L		ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
Vanadium, Dissolved	ug/L		ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)
Zinc, Dissolved (s)	ug/L	P128	147	228	605	147	268	279
Volatile and Semivolatile Organics								
4-Chloro-3-methylphenol	ug/L	P022	ND(20.0)	ND(20.0)	ND(22.0)	ND(20.0)	ND(22.0)	ND(20.8)
Bis(2-ethylhexyl) phthalate	ug/L	P066	ND(20.0)	ND(20.0)	ND(22.0)	ND(20.0)	ND(22.0)	ND(20.8)
Chloroform (s)	ug/L	P023	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)
Diethyl phthalate	ug/L	P070	ND(20.0)	ND(20.0)	ND(22.0)	ND(20.0)	ND(22.0)	ND(20.8)
Phenol (e) (s)	ug/L	P065	61.7	64.3	67.0	71.0	71.0	67.0
Toluene	ug/L	P086	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-5

Graywater Treatment System: Performance Data for Pathogen Indicators, Holland America Oosterdam

Pathogen indicators performance data for the Oosterdam's ROCHEM graywater treatment system. Average analyte concentrations were determined from the daily results presented in Tables 4-2 through 4-4. Percent removals were calculated using the average influent to and effluent from treatment analyte concentrations.

Analyte	Unit	Average Influent to Graywater Treatment Concentration (SP-6) (a)	Average Influent to Graywater UV Disinfection Concentration (SP-7) (a)	Average Effluent from Graywater Treatment Concentration (SP-8) (a)	Percent Removal
Pathogen Indicators					
E. coli	MPN/100 mL	53,600	<23.8	<1.35	>99
Enterococci	MPN/100 mL	#1,070	<1.00	ND(1.00)	>99
Fecal Coliform	CFU/100 mL	<21,800,000	7,030	<1.82	>99

(a) Sampling point location; see Figure 2-2.
ND - Not detected (number in parentheses is detection limit).
< - Average result reported includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.
- Average result includes at least one nondetect value (calculation uses detection limits for nondetected results) and at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-6

Graywater Treatment System: Performance Data for Analytes Other Than Pathogen Indicators, Holland America Oosterdam

Performance data for the Oosterdam's ROCHEM graywater treatment system for analytes other than pathogen indicators detected in either the influent to or effluent from graywater treatment. Range and average analyte concentrations were determined from the daily results presented in Tables 4-2 and 4-4. Percent removals were calculated using the average graywater influent and effluent analyte concentrations. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Average Influent to GW Treatment Concentration (SP-6) (a)	Influent to GW Treatment Concentration Range (SP-6) (a)	Average Effluent from GW Treatment Concentration (SP-8) (a)	Effluent from GW Treatment Concentration Range (SP-8) (a)	Percent Removal
Classical Pollutants							
Alkalinity	mg/L		43.5	31.8 - 56.4	<22.3	ND(10.0) - 34.9	49
Biochemical Oxygen Demand (BOD_5)	mg/L		143	132 - 149	28.1	23.2 - 37.3	80
Chemical Oxygen Demand (COD) (s)	mg/L		405	335 - 538	62.3	50.5 - 79.0	85
Chloride (s)	mg/L		18.6	13.0 - 25.0	13.4	8.00 - 17.0	28
Hardness (e) (s)	mg/L		6.14	5.18 - 8.88	1.10	0.390 - 1.90	82
Hexane Extractable Material (HEM)	mg/L		64.2	37.0 - 143	ND(6.00)	ND(6.00)	> 91
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		0.0360	0.0110 - 0.120	<0.0202	ND(0.0100) - 0.0270	44
Settleable Residue	mL/L		1.14	0.500 - 3.00	ND(0.109)	ND(0.105) - ND(0.110)	> 90
Silica Gel Treated HEM (SGT-HEM)	mg/L		<6.20	ND(6.00) - 7.00	ND(6.00)	ND(6.00)	> 3.2
Sulfate (s)	mg/L		10.8	6.91 - 12.2	3.05	2.17 - 4.17	72
Total Dissolved Solids (TDS)	mg/L		107	64.0 - 160	<35.1	ND(10.0) - 67.0	67
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		9.08	0.380 - 15.5	2.15	0.0800 - 6.74	76
Total Organic Carbon (TOC) (s)	mg/L		53.4	44.5 - 60.4	15.9	12.9 - 21.0	70
Total Phosphorus	mg/L		1.70	0.850 - 3.94	0.176	0.120 - 0.220	90
Total Suspended Solids (TSS)	mg/L		89.2	73.0 - 99.0	ND(5.00)	ND(5.00)	> 94

(a) Sampling point location; see Figure 2-2.
(e) Analyte detected at some level in equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-6 (Continued)

Analyte	Unit	Priority Pollutant Code	Average Influent to GW Treatment Concentration (SP-6) (a)	Influent to GW Treatment Concentration Range (SP-6) (a)	Average Effluent from GW Treatment Concentration (SP-8) (a)	Effluent from GW Treatment Concentration Range (SP-8) (a)	Percent Removal
Total and Dissolved Metals							
Aluminum, Total	ug/L		744	653 - 1,020	<15.2	ND(8.80) - 28.0	98
Arsenic, Total	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	NC
Barium, Total (e) (s)	ug/L		135	134 - 137	18.6	8.60 - 31.9	86
Boron, Total	ug/L		<29.3	ND(18.0) - 74.3	<38.9	ND(18.0) - 83.0	NC
Cadmium, Total	ug/L	P118	ND(0.0800)	ND(0.0800)	<0.0813	ND(0.0800) - <0.0867	NC
Calcium, Total (e) (s)	ug/L		1,680	1,570 - 1,960	269	112 - 502	84
Chromium, Total	ug/L	P119	5.25	2.76 - 9.52	ND(0.270)	ND(0.270)	> 95
Cobalt, Total	ug/L		ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	NC
Copper, Total (e) (s)	ug/L	P120	213	156 - 289	69.9	22.5 - 167	67
Iron, Total (e) (s)	ug/L		374	334 - 423	405	193 - 720	NC
Lead, Total (e) (s)	ug/L	P122	7.38	5.41 - 9.34	<8.50	ND(0.620) - 28.5	NC
Magnesium, Total (s)	ug/L		471	305 - 968	106	34.4 - 216	77
Manganese, Total (e) (s)	ug/L		7.85	6.95 - 8.87	22.5	3.77 - 81.1	NC
Mercury, Total	ug/L	P123	<0.0580	ND(0.0500) - 0.0850	ND(0.0500)	ND(0.0500)	> 14
Molybdenum, Total	ug/L		ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)	NC
Nickel, Total (s)	ug/L	P124	17.1	14.5 - 18.5	3.18	2.23 - 5.22	81
Selenium, Total	ug/L	P125	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)	NC
Silver, Total	ug/L	P126	<1.37	ND(0.770) - 2.27	ND(0.770)	ND(0.770)	> 44
Sodium, Total (s)	ug/L		21,300	16,000 - 26,400	14,000	11,300 - 20,000	34
Tin, Total	ug/L		<2.46	ND(0.940) - 6.92	ND(0.940)	ND(0.940)	> 62

(a) Sampling point location; see Figure 2-2.
(e) Analyte detected at some level in equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-6 (Continued)

Analyte	Unit	Priority Pollutant Code	Average Influent to GW Treatment Concentration (SP-6) (a)	Influent to GW Treatment Concentration Range (SP-6) (a)	Average Effluent from GW Treatment Concentration (SP-8) (a)	Effluent from GW Treatment Concentration Range (SP-8) (a)	Percent Removal
Titanium, Total	ug/L		2.04	1.47 - 3.51	ND(0.620)	ND(0.620)	> 70
Vanadium, Total	ug/L		<0.696	ND(0.470) - 0.890	ND(0.470)	ND(0.470)	> 32
Zinc, Total (e) (s)	ug/L	P128	791	598 - 924	383	196 - 675	52
Aluminum, Dissolved	ug/L		233	183 - 279	<10.4	ND(8.80) - <16.9	96
Antimony, Dissolved	ug/L	P114	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	NC
Arsenic, Dissolved	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	NC
Barium, Dissolved (e) (s)	ug/L		48.6	25.3 - 78.4	9.80	2.58 - 21.7	80
Beryllium, Dissolved	ug/L	P117	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	NC
Boron, Dissolved (e)	ug/L		<71.1	ND(18.0) - 114	<50.3	ND(18.0) - 83.7	29
Cadmium, Dissolved (e)	ug/L	P118	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	NC
Calcium, Dissolved (s)	ug/L		1,230	761 - 1,630	<208	ND(7.00) - 478	83
Chromium, Dissolved	ug/L	P119	0.564	0.370 - 0.760	<0.304	ND(0.270) - 0.440	46
Cobalt, Dissolved (s)	ug/L		3.20	1.72 - 5.11	<1.80	ND(0.660) - 3.61	44
Copper, Dissolved (s)	ug/L	P120	109	70.6 - 205	18.3	2.96 - 47.0	83
Iron, Dissolved (e)	ug/L		189	165 - 212	256	103 - 445	NC
Lead, Dissolved (e) (s)	ug/L	P122	2.22	1.01 - 4.47	<4.37	ND(0.620) - 14.8	NC
Magnesium, Dissolved (s)	ug/L		427	234 - 929	<99.1	ND(6.30) - 196	77
Manganese, Dissolved (s)	ug/L		10.3	7.30 - 14.9	8.82	6.21 - 14.1	15
Mercury, Dissolved	ug/L	P123	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)	NC
Nickel, Dissolved (s)	ug/L	P124	13.8	12.6 - 15.5	<3.30	ND(0.310) - 5.24	76
Silver, Dissolved	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	NC

(a) Sampling point location; see Figure 2-2.
(e) Analyte detected at some level in equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-6 (Continued)

Analyte	Unit	Priority Pollutant Code	Average Influent to GW Treatment Concentration (SP-6) (a)	Influent to GW Treatment Concentration Range (SP-6) (a)	Average Effluent from GW Treatment Concentration (SP-8) (a)	Effluent from GW Treatment Concentration Range (SP-8) (a)	Percent Removal
Sodium, Dissolved (e) (s)	ug/L		24,100	19,100 - 30,700	14,000	11,500 - 18,600	42
Tin, Dissolved	ug/L		<0.960	ND(0.940) - 1.04	ND(0.940)	ND(0.940)	> 2.1
Titanium, Dissolved	ug/L		<0.682	ND(0.620) - 0.920	ND(0.620)	ND(0.620)	> 9.1
Vanadium, Dissolved	ug/L		ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	NC
Zinc, Dissolved (s)	ug/L	P128	170	130 - 252	279	147 - 605	NC
Volatile and Semivolatile Organics							
4-Chloro-3-methylphenol	ug/L	P022	ND(10.6)	ND(10.0) - ND(12.0)	ND(20.8)	ND(20.0) - ND(22.0)	NC
Bis(2-ethylhexyl) phthalate	ug/L	P066	<15.0	ND(10.0) - 23.0	ND(20.8)	ND(20.0) - ND(22.0)	NC
Chloroform (s)	ug/L	P023	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	NC
Diethyl phthalate	ug/L	P070	<12.4	ND(10.0) - 14.0	ND(20.8)	ND(20.0) - ND(22.0)	NC
Phenol (e) (s)	ug/L	P065	49.4	32.0 - 62.0	67.0	61.7 - 71.0	NC
Toluene	ug/L	P086	<5.20	ND(5.00) - 6.00	ND(5.00)	ND(5.00)	> 3.8

(a) Sampling point location; see Figure 2-2.
(e) Analyte detected at some level in equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-7

Influent to Sewage/Graywater Treatment System Analytical Results, Holland America Oosterdam

Analytical results for the influent to the sewage/graywater (Sewage/GW) treatment system for analytes detected at least once in wastewater samples during the sampling episode. See Appendices A-1 and A-2 for all analytical results (detected and nondetected). Influent to sewage/graywater treatment system samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for the sample collection methodology. Figure 2-3 identifies sampling point location. Average influent to treatment concentrations determined from the daily results. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Influent to Sewage/GW Treatment (SP-11) (a) Day 1	Influent to Sewage/GW Treatment (SP-11) (a) Day 2	Influent to Sewage/GW Treatment (SP-11) (a) Day 3	Influent to Sewage/GW Treatment (SP-11) (a) Day 4	Influent to Sewage/GW Treatment (SP-11) (a) Day 5	Average Influent to Sewage/GW Treatment (SP-12) (a)
Pathogen Indicators								
E. coli (b)	MPN/100 mL		10,400,000 [N=2]	10,100,000 [N=2]	8,940,000 [N=2]	7,050,000 [N=2]	5,940,000 [N=2]	8,480,000
Enterococci (b)	MPN/100 mL		1,400,000 [N=2]	1,970,000 [N=2]	949,000 [N=2]	819,000 [N=2]	602,000 [N=2]	1,150,000
Fecal Coliform (b)	CFU/100 mL		52,000,000 [N=2]	15,000,000 [N=2]	8,950,000 [N=2]	28,000,000 [N=2]	30,800,000 [N=2]	26,900,000
Classical Pollutants								
Alkalinity	mg/L		529	537	508	650	564	558
Biochemical Oxygen Demand (BOD_5)	mg/L		919	1,380	690	736	717	888
Chemical Oxygen Demand (COD) (s)	mg/L		2,490	2,830	1,800	1,960	2,040	2,220
Chloride (s)	mL/L		125	95.0	125	145	145	127
Hardness (e) (s)	mg/L		51.8	28.5	51.3	40.7	44.4	43.3
Hexane Extractable Material (HEM)	mg/L		52.0	85.0	62.0	50.0	48.0	59.4
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		0.0170	0.0160	0.0290	0.0370	0.0350	0.0268
Settleable Residue	mL/L		20.0	51.0	39.0	ND(0.130)	0.660	<22.2
Silica Gel Treated HEM (SGT-HEM)	mg/L		7.00	8.00	8.00	6.00	6.00	7.00
Sulfate (s)	mg/L		113	121	131	153	96.5	123

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-7 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to Sewage/GW Treatment (SP-11) (a) Day 1	Influent to Sewage/GW Treatment (SP-11) (a) Day 2	Influent to Sewage/GW Treatment (SP-11) (a) Day 3	Influent to Sewage/GW Treatment (SP-11) (a) Day 4	Influent to Sewage/GW Treatment (SP-11) (a) Day 5	Average Influent to Sewage/GW Treatment (SP-12) (a)
Total Dissolved Solids (TDS)	mg/L		756	608	596	842	788	718
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		192	197	192	200	182	193
Total Organic Carbon (TOC) (s)	mg/L		262	225	271	302	267	265
Total Phosphorus	mg/L		23.1	24.2	20.9	23.3	31.8	24.7
Total Suspended Solids (TSS)	mg/L		650	1,110	635	560	680	727
Total and Dissolved Metals								
Aluminum, Total	ug/L		1,360	847	1,460	1,330	1,630	1,330
Arsenic, Total	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Total (e) (s)	ug/L		318	185	309	234	273	264
Boron, Total	ug/L		ND(18.0)	ND(18.0)	ND(18.0)	98.5	121	<54.7
Cadmium, Total	ug/L	P118	0.380	0.220	0.520	0.380	0.470	0.394
Calcium, Total (e) (s)	ug/L		13,900	6,870	13,700	9,550	11,200	11,000
Chromium, Total	ug/L	P119	8.63	4.52	12.6	7.66	8.78	8.44
Cobalt, Total	ug/L		ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)
Copper, Total (e) (s)	ug/L	P120	384	372	542	468	490	451
Iron, Total (e) (s)	ug/L		1,190	820	1,560	1,220	1,460	1,250
Lead, Total (e) (s)	ug/L	P122	7.85	7.94	10.7	10.1	13.4	10.0
Magnesium, Total (s)	ug/L		4,130	2,760	4,150	4,100	3,980	3,820
Manganese, Total (e) (s)	ug/L		68.8	44.1	58.7	65.7	62.6	60.0
Mercury, Total	ug/L	P123	0.240	0.190	0.220	0.190	0.260	0.220
Molybdenum, Total	ug/L		2.43	ND(1.60)	2.08	1.82	ND(1.60)	<1.91

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-7 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to Sewage/GW Treatment (SP-11) (a) Day 1	Influent to Sewage/GW Treatment (SP-11) (a) Day 2	Influent to Sewage/GW Treatment (SP-11) (a) Day 3	Influent to Sewage/GW Treatment (SP-11) (a) Day 4	Influent to Sewage/GW Treatment (SP-11) (a) Day 5	Average Influent to Sewage/GW Treatment (SP-12) (a)
Nickel, Total (s)	ug/L	P124	22.8	20.9	35.5	28.1	32.1	27.9
Selenium, Total	ug/L	P125	ND(1.40)	ND(1.40)	2.85	2.70	2.99	<2.27
Silver, Total	ug/L	P126	3.11	1.24	5.28	2.40	2.52	2.91
Sodium, Total (s)	ug/L		81,500	61,900	88,100	103,000	90,800	85,100
Tin, Total	ug/L		6.52	5.20	8.83	8.79	8.47	7.56
Titanium, Total	ug/L		2.79	2.38	3.29	3.01	3.63	3.02
Vanadium, Total	ug/L		1.50	0.540	1.64	1.63	ND(0.470)	<1.16
Zinc, Total (e) (s)	ug/L	P128	1,440	1,000	3,190	1,580	1,730	1,790
Aluminum, Dissolved	ug/L		235	310	244	408	464	332
Antimony, Dissolved	ug/L	P114	ND(2.00)	ND(2.00)	ND(2.00)	2.78	ND(2.00)	<2.16
Arsenic, Dissolved	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Dissolved (e) (s)	ug/L		84.7	59.4	88.7	73.9	100	81.3
Beryllium, Dissolved	ug/L	P117	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)
Boron, Dissolved (e)	ug/L		109	129	ND(18.0)	ND(18.0)	ND(18.0)	<58.4
Cadmium, Dissolved (e)	ug/L	P118	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)
Calcium, Dissolved (s)	ug/L		5,770	3,080	5,170	4,480	6,360	4,970
Chromium, Dissolved	ug/L	P119	2.06	1.83	4.11	2.91	3.51	2.88
Cobalt, Dissolved (s)	ug/L		5.78	9.36	5.46	13.7	23.3	11.5
Copper, Dissolved (s)	ug/L	P120	56.6	153	86.6	130	125	110
Iron, Dissolved (e)	ug/L		903	882	550	938	1,230	901
Lead, Dissolved (e) (s)	ug/L	P122	1.41	3.22	2.50	3.12	2.57	2.56

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-7 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to Sewage/GW Treatment (SP-11) (a) Day 1	Influent to Sewage/GW Treatment (SP-11) (a) Day 2	Influent to Sewage/GW Treatment (SP-11) (a) Day 3	Influent to Sewage/GW Treatment (SP-11) (a) Day 4	Influent to Sewage/GW Treatment (SP-11) (a) Day 5	Average Influent to Sewage/GW Treatment (SP-12) (a)
Magnesium, Dissolved (s)	ug/L		3,110	2,800	3,350	3,740	3,930	3,390
Manganese, Dissolved (s)	ug/L		64.7	62.5	33.0	86.4	96.3	68.6
Mercury, Dissolved	ug/L	P123	ND(0.0500)	ND(0.0500)	0.0570	0.0550	ND(0.0500)	<0.0524
Nickel, Dissolved (s)	ug/L	P124	21.1	29.1	27.3	28.1	33.3	27.8
Silver, Dissolved	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)
Sodium, Dissolved (e) (s)	ug/L		92,900	94,100	84,100	107,000	106,000	96,800
Tin, Dissolved	ug/L		2.19	2.58	2.49	2.94	2.49	2.54
Titanium, Dissolved	ug/L		0.840	0.960	ND(0.620)	0.670	0.840	<0.786
Vanadium, Dissolved	ug/L		0.560	0.560	0.490	0.760	0.730	0.620
Zinc, Dissolved (s)	ug/L	P128	409	524	644	569	459	521
Volatile and Semivolatile Organics								
4-Chloro-3-methylphenol	ug/L	P022	ND(10.0)	ND(10.0)	ND(11.0)	ND(13.0)	ND(12.0)	ND(11.2)
Bis(2-ethylhexyl) phthalate	ug/L	P066	49.0	94.0	45.0	47.0	47.0	56.4
Chloroform (s)	ug/L	P023	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)
Diethyl phthalate	ug/L	P070	ND(10.0)	ND(10.0)	ND(11.0)	ND(13.0)	ND(12.0)	ND(11.2)
Phenol (e) (s)	ug/L	P065	95.0	67.0	60.0	100	150	94.4
Toluene	ug/L	P086	ND(5.00)	ND(5.00)	6.00	7.00	7.00	<6.00
Polychlorinated Biphenyls								
PCB-2	pg/L		17.5	NC	NC	NC	NC	
PCB-6	pg/L		121	NC	NC	NC	NC	
PCB-11	pg/L		1,900	NC	NC	NC	NC	

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-7 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to Sewage/GW Treatment (SP-11) (a) Day 1	Influent to Sewage/GW Treatment (SP-11) (a) Day 2	Influent to Sewage/GW Treatment (SP-11) (a) Day 3	Influent to Sewage/GW Treatment (SP-11) (a) Day 4	Influent to Sewage/GW Treatment (SP-11) (a) Day 5	Average Influent to Sewage/GW Treatment (SP-12) (a)
PCB-16	pg/L		367	NC	NC	NC	NC	
PCB-17	pg/L		360	NC	NC	NC	NC	
PCB-18+PCB-30	pg/L		704	NC	NC	NC	NC	
PCB-20+PCB-28	pg/L		1,080	NC	NC	NC	NC	
PCB-21+PCB-33	pg/L		603	NC	NC	NC	NC	
PCB-22	pg/L		399	NC	NC	NC	NC	
PCB-31	pg/L		891	NC	NC	NC	NC	
PCB-44+PCB-47+PCB-65	pg/L		849	NC	NC	NC	NC	
PCB-52	pg/L		654	NC	NC	NC	NC	
PCB-61+PCB-70+PCB-74+PCB-76	pg/L		1,190	NC	NC	NC	NC	
PCB-64	pg/L		279	NC	NC	NC	NC	
PCB-129+PCB-138+PCB-160+PCB-163	pg/L		958	NC	NC	NC	NC	
PCB-153+PCB-168	pg/L		1,070	NC	NC	NC	NC	
PCB-180+PCB-193	pg/L		620	NC	NC	NC	NC	
Total Dichloro Biphenyls	pg/L		2,020	NC	NC	NC	NC	
Total Hexachloro Biphenyls	pg/L		2,030	NC	NC	NC	NC	
Total PCBs	pg/L		11,400	NC	NC	NC	NC	
Total Tetrachloro Biphenyls	pg/L		2,970	NC	NC	NC	NC	
Total Trichloro Biphenyls	pg/L		4,400	NC	NC	NC	NC	

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with two grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-8

Influent to Sewage/Graywater UV Disinfection Analytical Results, Holland America Oosterdam

Analytical results for the influent to UV disinfection part of the sewage/graywater wastewater treatment system. Influent to UV disinfection samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for the sample collection methodology. Figure 2-3 identifies sampling point location. Average influent to UV concentrations determined from the daily results.

Analyte	Unit	Influent to Sewage/GW UV (SP-12) (a) Day 1	Influent to Sewage/GW UV (SP-12) (a) Day 2	Influent to Sewage/GW UV (SP-12) (a) Day 3	Influent to Sewage/GW UV (SP-12) (a) Day 4	Influent to Sewage/GW UV (SP-12) (a) Day 5	Average Influent to Sewage/GW UV
Pathogen Indicators							
E. coli (b)	MPN/100 mL	13.9 [N=3]	22.2 [N=3]	141 [N=3]	192 [N=3]	< 22.4 [N=3]	<78.3
Enterococci (b)	MPN/100 mL	24.8 [N=3]	128 [N=3]	> 1,120 [N=3]	408 [N=3]	< 12.1 [N=3]	#338
Fecal Coliform (b)	CFU/100 mL	33.0 [N=3]	30.3 [N=3]	113 [N=3]	294 [N=3]	30.0 [N=3]	100

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).
- Average result includes at least one nondetect value (calculation uses detection limits for nondetected results) and at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-9

Effluent from Sewage/Graywater Treatment System Analytical Results, Holland America Oosterdam

Analytical results for the effluent from sewage/graywater treatment system for analytes detected at least once in wastewater samples during the sampling episode. See Appendices A-1and A-2 for all analytical results (detected and nondetected). Effluent from treatment system samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for sample collection methodology. Figure 2-3 identifies sampling point location. Average effluent from treatment concentrations determined from the daily results. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Effluent from Sewage/GW Treatment (SP-13) (a) Day 1	Effluent from Sewage/GW Treatment (SP-13) (a) Day 2	Effluent from Sewage/GW Treatment (SP-13) (a) Day 3	Effluent from Sewage/GW Treatment (SP-13) (a) Day 4	Effluent from Sewage/GW Treatment (SP-13) (a) Day 5	Average Effluent from Sewage/GW Treatment (SP-13) (a)
Pathogen Indicators								
E. coli (b)	MPN/100 mL		ND(1.00) [N=3]	ND(1.00) [N=3]	ND(1.00) [N=3]	ND(1.00) [N=3]	< 5.07 [N=3]	<1.81
Enterococci (b)	MPN/100 mL		< 1.00 [N=3]	< 1.00 [N=3]	ND(1.00) [N=3]	ND(1.00) [N=3]	< 62.0 [N=3]	<13.2
Fecal Coliform (b)	CFU/100 mL		ND(1.00) [N=3]	ND(1.33) [N=3]	ND(2.00) [N=3]	ND(2.00) [N=3]	ND(2.00) [N=3]	ND(1.67)
Classical Pollutants								
Alkalinity	mg/L		321	436	319	362	338	355
Biochemical Oxygen Demand (BOD_5)	mg/L		3.87	5.89	3.93	4.25	3.18	4.22
Chemical Oxygen Demand (COD) (s)	mg/L		148	112	102	109	123	119
Chloride (s)	mg/L		125	85.0	125	145	142	124
Hardness (e) (s)	mg/L		37.7	34.4	33.0	34.1	32.3	34.3
Hexane Extractable Material (HEM)	mg/L		ND(6.00)	ND(5.00)	ND(5.00)	ND(6.00)	ND(6.00)	ND(5.60)
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		0.0950	0.0160	0.0770	0.0323	0.0590	0.0559
Settleable Residue	mL/L		ND(0.115)	ND(0.120)	ND(0.130)	ND(0.110)	ND(0.103)	ND(0.116)
Silica Gel Treated HEM (SGT-HEM)	mg/L		ND(6.00)	ND(5.00)	ND(5.00)	ND(6.00)	ND(6.00)	ND(5.60)
Sulfate (s)	mg/L		43.5	34.9	46.5	53.2	24.9	40.6
Total Dissolved Solids (TDS)	mL/L		470	434	442	493	513	470

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-9 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from Sewage/GW Treatment (SP-13) (a) Day 1	Effluent from Sewage/GW Treatment (SP-13) (a) Day 2	Effluent from Sewage/GW Treatment (SP-13) (a) Day 3	Effluent from Sewage/GW Treatment (SP-13) (a) Day 4	Effluent from Sewage/GW Treatment (SP-13) (a) Day 5	Average Effluent from Sewage/GW Treatment (SP-13) (a)
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		4.13	83.2	68.6	72.4	64.0	58.5
Total Organic Carbon (TOC) (s)	mg/L		45.4	36.0	42.2	30.2	33.9	37.5
Total Phosphorus	mg/L		23.7	14.4	11.1	10.7	13.1	14.6
Total Suspended Solids (TSS)	mg/L		ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)
Total and Dissolved Metals								
Aluminum, Total	ug/L		125	138	76.9	108	111	112
Arsenic, Total	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Total (e) (s)	ug/L		77.2	73.8	76.8	75.9	69.3	74.6
Boron, Total	ug/L		ND(18.0)	ND(18.0)	158	116	132	<88.3
Cadmium, Total	ug/L	P118	0.105	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	<0.0850
Calcium, Total (e) (s)	ug/L		9,580	8,790	8,800	8,960	8,500	8,920
Chromium, Total	ug/L	P119	0.750	0.530	1.92	1.75	1.63	1.32
Cobalt, Total	ug/L		ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)
Copper, Total (e) (s)	ug/L	P120	58.7	6.51	5.81	3.49	7.80	16.5
Iron, Total (e) (s)	ug/L		758	749	270	541	901	644
Lead, Total (e) (s)	ug/L	P122	7.56	3.74	2.10	2.10	7.07	4.51
Magnesium, Total (s)	ug/L		3,350	3,020	2,690	2,850	2,690	2,920
Manganese, Total (e) (s)	ug/L		52.7	55.6	14.8	45.1	41.3	41.9
Mercury, Total	ug/L	P123	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)	ND(0.0500)
Molybdenum, Total	ug/L		ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)
Nickel, Total (s)	ug/L	P124	24.7	28.6	25.2	30.1	33.2	28.3

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-9 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from Sewage/GW Treatment (SP-13) (a) Day 1	Effluent from Sewage/GW Treatment (SP-13) (a) Day 2	Effluent from Sewage/GW Treatment (SP-13) (a) Day 3	Effluent from Sewage/GW Treatment (SP-13) (a) Day 4	Effluent from Sewage/GW Treatment (SP-13) (a) Day 5	Average Effluent from Sewage/GW Treatment (SP-13) (a)
Selenium, Total	ug/L	P125	ND(1.40)	ND(1.40)	< 2.18	ND(1.40)	ND(1.40)	<1.56
Silver, Total	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)
Sodium, Total (s)	ug/L		103,000	101,000	106,000	120,000	114,000	109,000
Tin, Total	ug/L		ND(0.940)	ND(0.940)	< 0.993	ND(0.940)	ND(0.940)	<0.951
Titanium, Total	ug/L		ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
Vanadium, Total	ug/L		ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)
Zinc, Total (e) (s)	ug/L	P128	905	568	363	720	1,050	721
Aluminum, Dissolved	ug/L		113	116	78.4	116	161	117
Antimony, Dissolved	ug/L	P114	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Arsenic, Dissolved	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Dissolved (e) (s)	ug/L		70.1	64.7	74.2	80.1	88.6	75.5
Beryllium, Dissolved	ug/L	P117	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)
Boron, Dissolved (e)	ug/L		137	114	ND(18.0)	ND(18.0)	ND(18.0)	<61.0
Cadmium, Dissolved (e)	ug/L	P118	< 0.105	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	<0.0850
Calcium, Dissolved (s)	ug/L		8,690	7,920	8,170	9,330	10,900	9,000
Chromium, Dissolved	ug/L	P119	1.32	1.24	1.35	1.43	2.02	1.47
Cobalt, Dissolved (s)	ug/L		ND(0.660)	1.60	< 1.46	1.93	3.76	<1.88
Copper, Dissolved (s)	ug/L	P120	53.9	6.33	4.67	3.60	10.5	15.8
Iron, Dissolved (e)	ug/L		781	736	274	507	1,130	685
Lead, Dissolved (e) (s)	ug/L	P122	6.92	5.08	1.71	2.03	7.98	4.74
Magnesium, Dissolved (s)	ug/L		3,050	2,710	2,580	3,000	3,460	2,960

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-9 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from Sewage/GW Treatment (SP-13) (a) Day 1	Effluent from Sewage/GW Treatment (SP-13) (a) Day 2	Effluent from Sewage/GW Treatment (SP-13) (a) Day 3	Effluent from Sewage/GW Treatment (SP-13) (a) Day 4	Effluent from Sewage/GW Treatment (SP-13) (a) Day 5	Average Effluent from Sewage/GW Treatment (SP-13) (a)
Manganese, Dissolved (s)	ug/L		49.6	53.2	17.3	50.4	64.7	47.0
Mercury, Dissolved	ug/L	P123	< 0.0555	ND(0.0500)	< 0.0680	ND(0.0500)	0.0950	<0.0637
Nickel, Dissolved (s)	ug/L	P124	24.6	28.7	22.8	29.6	41.2	29.4
Silver, Dissolved	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)
Sodium, Dissolved (e) (s)	ug/L		103,000	102,000	94,000	117,000	134,000	110,000
Tin, Dissolved	ug/L		ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)
Titanium, Dissolved	ug/L		ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
Vanadium, Dissolved	ug/L		ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)
Zinc, Dissolved (s)	ug/L	P128	849	528	354	687	1,360	755
Volatile and Semivolatile Organics								
4-Chloro-3-methylphenol	ug/L	P022	ND(10.0)	ND(10.0)	ND(24.0)	ND(22.0)	ND(21.0)	ND(17.4)
Bis(2-ethylhexyl) phthalate	ug/L	P066	ND(10.0)	ND(10.0)	ND(24.0)	ND(22.0)	ND(21.0)	ND(17.4)
Chloroform (s)	ug/L	P023	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)
Diethyl phthalate	ug/L	P070	ND(10.0)	ND(10.0)	ND(24.0)	ND(22.0)	ND(21.0)	ND(17.4)
Phenol (e) (s)	ug/L	P065	48.0	60.0	71.0	69.0	69.0	63.4
Toluene	ug/L	P086	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)

(a) Sampling point location; see Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-10

Sewage/Graywater Treatment System: Performance Data for Pathogen Indicators, Holland America Oosterdam

Pathogen indicators performance data for the Oosterdam's ROCHEM sewage/graywater treatment system. Average analyte concentrations were determined from the daily results presented in Tables 4-7 through 4-9. Percent removals were calculated using the average influent to and effluent from treatment analyte concentrations.

Analyte	Unit	Average Influent to Sewage/GW Treatment Concentration (SP-11) (a)	Average Influent to Sewage/GW UV Disinfection Concentration (SP-12) (a)	Average Effluent from Sewage/GW Treatment Concentration (SP-13) (a)	Percent Removal
Pathogen Indicators					
E. coli	MPN/100 mL	8,480,000	<78.3	<1.81	>99
Enterococci	MPN/100 mL	1,150,000	#338	<13.2	>99
Fecal Coliform	CFU/100 mL	26,900,000	100	ND(1.67)	>99

(a) Sampling point location; see Figure 2-3.
ND - Not detected (number in parentheses is detection limit).
< - Average result reported includes at least one nondetect value (calculation uses detection limit for nondetected results.).
> - Indicates a minimum level of removal.
- Average result includes at least one nondetect value (calculation uses detection limits for nondetected results) and at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-11

Sewage/Graywater Treatment System: Performance Data for Analytes Other than Pathogen Indicators, Holland America Oosterdam

Performance data for the Oosterdam's ROCHEM sewage/graywater Reverse Osmosis treatment system for analytes other than pathogen indicators detected in either the influent to or effluent from sewage/graywater treatment. Range and average analyte concentrations were determined from the daily results presented in Tables 4-7 and 4-9. Percent removals were calculated using the average sewage/graywater influent and effluent analyte concentrations. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Average Influent to Sewage/GW Treatment Concentration (SP-11) (a)	Influent to Sewage/GW Treatment Concentration Range (SP-11) (a)	Average Effluent from Sewage/GW Treatment Concentration (SP-13) (a)	Effluent from Sewage/GW Treatment Concentration Range (SP-13) (a)	Percent Removal
Classical Pollutants							
Alkalinity	mg/L		558	508 - 650	355	319 - 436	36
Biochemical Oxygen Demand (BOD_5)	mg/L		888	690 - 1,380	4.22	3.18 - 5.89	> 99
Chemical Oxygen Demand (COD) (s)	mg/L		2,220	1,800 - 2,830	119	102 - 148	95
Chloride (s)	mg/L		127	95.0 - 145	124	85.0 - 145	2.1
Hardness (e) (s)	mg/L		43.3	28.5 - 51.8	34.3	32.3 - 37.7	21
Hexane Extractable Material (HEM)	mg/L		59.4	48.0 - 85.0	ND(5.60)	ND(5.00) - ND(6.00)	> 91
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		0.0268	0.0160 - 0.0370	0.0559	0.0160 - 0.0950	NC
Settleable Residue	mL/L		<22.2	ND(0.130) - 51.0	ND(0.116)	ND(0.103) - ND(0.130)	> 99
Silica Gel Treated HEM (SGT-HEM)	mg/L		7.00	6.00 - 8.00	ND(5.60)	ND(5.00) - ND(6.00)	> 20
Sulfate (s)	mg/L		123	96.5 - 153	40.6	24.9 - 53.2	67
Total Dissolved Solids (TDS)	mg/L		718	596 - 842	470	434 - 513	34
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		193	182 - 200	58.5	4.13 - 83.2	70
Total Organic Carbon (TOC) (s)	mg/L		265	225 - 302	37.5	30.2 - 45.4	86
Total Phosphorus	mg/L		24.7	20.9 - 31.8	14.6	10.7 - 23.7	41
Total Suspended Solids (TSS)	mg/L		727	560 - 1,110	ND(5.00)	ND(5.00)	> 99

(a) Sampling point location; see Figure 2-3.
(e) Analyte detected at some level in equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-11 (Continued)

Analyte	Unit	Priority Pollutant Code	Average Influent to Sewage/GW Treatment Concentration (SP-11) (a)	Influent to Sewage/GW Treatment Concentration Range (SP-11) (a)	Average Effluent from Sewage/GW Treatment Concentration (SP-13) (a)	Effluent from Sewage/GW Treatment Concentration Range (SP-13) (a)	Percent Removal
Total and Dissolved Metals							
Aluminum, Total	ug/L		1,330	847 - 1,630	112	76.9 - 138	92
Arsenic, Total	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	NC
Barium, Total (e) (s)	ug/L		264	185 - 318	74.6	69.3 - 77.2	72
Boron, Total	ug/L		<54.7	ND(18.0) - 121	<88.3	ND(18.0) - 158	NC
Cadmium, Total	ug/L	P118	0.394	0.220 - 0.520	<0.0850	ND(0.0800) - 0.105	78
Calcium, Total (e) (s)	ug/L		11,000	6,870 - 13,900	8,920	8,500 - 9,580	19
Chromium, Total	ug/L	P119	8.44	4.52 - 12.6	1.32	0.530 - 1.92	84
Cobalt, Total	ug/L		ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	NC
Copper, Total (e) (s)	ug/L	P120	451	372 - 542	16.5	3.49 - 58.7	96
Iron, Total (e) (s)	ug/L		1,250	820 - 1,560	644	270 - 901	48
Lead, Total (e) (s)	ug/L	P122	10.0	7.85 - 13.4	4.51	2.10 - 7.56	55
Magnesium, Total (s)	ug/L		3,820	2,760 - 4,150	2,920	2,690 - 3,350	24
Manganese, Total (e) (s)	ug/L		60.0	44.1 - 68.8	41.9	14.8 - 55.6	30
Mercury, Total	ug/L	P123	0.220	0.190 - 0.260	ND(0.0500)	ND(0.0500)	> 77
Molybdenum, Total	ug/L		<1.91	ND(1.60) - 2.43	ND(1.60)	ND(1.60)	> 16
Nickel, Total (s)	ug/L	P124	27.9	20.9 - 35.5	28.3	24.7 - 33.2	NC
Selenium, Total	ug/L	P125	<2.27	ND(1.40) - 2.99	<1.56	ND(1.40) - <2.18	31
Silver, Total	ug/L	P126	2.91	1.24 - 5.28	ND(0.770)	ND(0.770)	> 74
Sodium, Total (s)	ug/L		85,100	61,900 - 103,000	109,000	101,000 - 120,000	NC
Tin, Total	ug/L		7.56	5.20 - 8.83	<0.951	ND(0.940) - <0.993	87

(a) Sampling point location; see Figure 2-3.
(e) Analyte detected at some level in equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-11 (Continued)

Analyte	Unit	Priority Pollutant Code	Average Influent to Sewage/GW Treatment Concentration (SP-11) (a)	Influent to Sewage/GW Treatment Concentration Range (SP-11) (a)	Average Effluent from Sewage/GW Treatment Concentration (SP-13) (a)	Effluent from Sewage/GW Treatment Concentration Range (SP-13) (a)	Percent Removal
Titanium, Total	ug/L		3.02	2.38 - 3.63	ND(0.620)	ND(0.620)	> 79
Vanadium, Total	ug/L		<1.16	ND(0.470) - 1.64	ND(0.470)	ND(0.470)	> 59
Zinc, Total (e) (s)	ug/L	P128	1,790	1,000 - 3,190	721	363 - 1,050	60
Aluminum, Dissolved	ug/L		332	235 - 464	117	78.4 - 161	65
Antimony, Dissolved	ug/L	P114	<2.16	ND(2.00) - 2.78	ND(2.00)	ND(2.00)	> 7.2
Arsenic, Dissolved	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	NC
Barium, Dissolved (e) (s)	ug/L		81.3	59.4 - 100	75.5	64.7 - 88.6	7.1
Beryllium, Dissolved	ug/L	P117	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	NC
Boron, Dissolved (e)	ug/L		<58.4	ND(18.0) - 129	<61.0	ND(18.0) - 137	NC
Cadmium, Dissolved (e)	ug/L	P118	ND(0.0800)	ND(0.0800)	<0.0850	ND(0.0800) - <0.105	NC
Calcium, Dissolved (s)	ug/L		4,970	3,080 - 6,360	9,000	7,920 - 10,900	NC
Chromium, Dissolved	ug/L	P119	2.88	1.83 - 4.11	1.47	1.24 - 2.02	49
Cobalt, Dissolved (s)	ug/L		11.5	5.46 - 23.3	<1.88	ND(0.660) - 3.76	84
Copper, Dissolved (s)	ug/L	P120	110	56.6 - 153	15.8	3.60 - 53.9	86
Iron, Dissolved (e)	ug/L		901	550 - 1,230	685	274 - 1,130	24
Lead, Dissolved (e) (s)	ug/L	P122	2.56	1.41 - 3.22	4.74	1.71 - 7.98	NC
Magnesium, Dissolved (s)	ug/L		3,390	2,800 - 3,930	2,960	2,580 - 3,460	13
Manganese, Dissolved (s)	ug/L		68.6	33.0 - 96.3	47.0	17.3 - 64.7	31
Mercury, Dissolved	ug/L	P123	<0.0524	ND(0.0500) - 0.0570	<0.0637	ND(0.0500) - 0.0950	NC
Nickel, Dissolved (s)	ug/L	P124	27.8	21.1 - 33.3	29.4	22.8 - 41.2	NC
Silver, Dissolved	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	NC

(a) Sampling point location; see Figure 2-3.
(e) Analyte detected at some level in equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-11 (Continued)

Analyte	Unit	Priority Pollutant Code	Average Influent to Sewage/GW Treatment Concentration (SP-11) (a)	Influent to Sewage/GW Treatment Concentration Range (SP-11) (a)	Average Effluent from Sewage/GW Treatment Concentration (SP-13) (a)	Effluent from Sewage/GW Treatment Concentration Range (SP-13) (a)	Percent Removal
Sodium, Dissolved (e) (s)	ug/L		96,800	84,100 - 107,000	110,000	94,000 - 134,000	NC
Tin, Dissolved	ug/L		2.54	2.19 - 2.94	ND(0.940)	ND(0.940)	> 63
Titanium, Dissolved	ug/L		<0.786	ND(0.620) - 0.960	ND(0.620)	ND(0.620)	> 21
Vanadium, Dissolved	ug/L		0.620	0.490 - 0.760	ND(0.470)	ND(0.470)	> 24
Zinc, Dissolved (s)	ug/L	P128	521	409 - 644	755	354 - 1,360	NC
Volatile and Semivolatile Organics							
4-Chloro-3-methylphenol	ug/L	P022	ND(11.2)	ND(10.0) - ND(13.0)	ND(17.4)	ND(10.0) - ND(24.0)	NC
Bis(2-ethylhexyl) phthalate	ug/L	P066	56.4	45.0 - 94.0	ND(17.4)	ND(10.0) - ND(24.0)	> 69
Chloroform (s)	ug/L	P023	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	NC
Diethyl phthalate	ug/L	P070	ND(11.2)	ND(10.0) - ND(13.0)	ND(17.4)	ND(10.0) - ND(24.0)	NC
Phenol (e) (s)	ug/L	P065	94.4	60.0 - 150	63.4	48.0 - 71.0	33
Toluene	ug/L	P086	<6.00	ND(5.00) - 7.00	ND(5.00)	ND(5.00)	> 17

(a) Sampling point location; see Figure 2-3.
(e) Analyte detected at some level in equipment blank. See Section 5.2.2 and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-12

Final Combined Treated Effluent, Holland America Oosterdam

Analytical results for the final combined treated effluent (graywater and sewage/graywater treatment effluents combined for overboard discharge) for analytes detected at least once in wastewater samples during the sampling episode. See Appendices A-1 and A-2 for all analytical results (detected and nondetected). Final combined treated effluent samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for the sample collection methodology. Average final combined effluent concentrations determined from the daily results. Priority pollutants (designated by EPA in CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Final Combined Discharge (SP-16) (a) Day 1	Final Combined Discharge (SP-16) (a) Day 2	Final Combined Discharge (SP-16) (a) Day 3	Final Combined Discharge (SP-16) (a) Day 4	Final Combined Discharge (SP-16) (a) Day 5	Average Final Combined Discharge (SP-16) (a)
Pathogen Indicators								
E. coli (b)	MPN/100 mL		< 25.3 [N=2]	< 3.43 [N=3]	ND(1.00) [N=3]	ND(1.00) [N=3]	ND(1.00) [N=3]	<6.35
Enterococci (b)	MPN/100 mL		6.45 [N=2]	< 1.00 [N=3]	ND(1.00) [N=3]	ND(1.00) [N=3]	< 1.00 [N=3]	<2.09
Fecal Coliform (b)	CFU/100 mL		ND(1.00) [N=2]	< 1.67 [N=3]	ND(2.00) [N=3]	< 2.00 [N=3]	ND(2.00) [N=3]	<1.73
Classical Pollutants								
Alkalinity	mg/L		161	146	138	98.4	155	140
Biochemical Oxygen Demand (BOD_5)	mg/L		17.5	19.8	17.0	18.9	15.0	17.6
Chemical Oxygen Demand (COD) (s)	mg/L		129	74.0	80.0	75.0	86.0	88.8
Chloride (s)	mg/L		595	75.0	75.0	475	45.0	253
Hardness (e) (s)	mg/L		114	24.3	20.1	113	18.8	58.0
Hexane Extractable Material (HEM)	mg/L		ND(6.00)	ND(5.00)	ND(6.00)	ND(6.00)	ND(6.00)	ND(5.80)
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		0.0630	0.0790	0.0690	0.0170	0.0560	0.0568
Settleable Residue	mL/L		ND(0.110)	ND(0.100)	ND(0.110)	ND(0.110)	ND(0.110)	ND(0.108)
Silica Gel Treated HEM (SGT-HEM)	mg/L		ND(6.00)	ND(5.00)	ND(6.00)	ND(6.00)	ND(6.00)	ND(5.80)

(a) Sampling point location; see Figure 2-2 and Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-12 (Continued)

Analyte	Unit	Priority Pollutant Code	Final Combined Discharge (SP-16) (a) Day 1	Final Combined Discharge (SP-16) (a) Day 2	Final Combined Discharge (SP-16) (a) Day 3	Final Combined Discharge (SP-16) (a) Day 4	Final Combined Discharge (SP-16) (a) Day 5	Average Final Combined Discharge (SP-16) (a)
Sulfate (s)	mg/L		89.2	16.6	20.0	68.4	23.2	43.5
Total Dissolved Solids (TDS)	mg/L		1,190	256	259	998	257	592
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		2.94	22.0	0.840	0.460	31.4	11.5
Total Organic Carbon (TOC) (s)	mg/L		21.7	20.7	19.5	12.6	21.9	19.3
Total Phosphorus	mg/L		3.61	4.06	31.6	2.82	6.31	9.68
Total Suspended Solids (TSS)	mg/L		ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)
Total and Dissolved Metals								
Aluminum, Total	ug/L		ND(8.80)	ND(8.80)	27.6	30.5	66.0	<28.3
Arsenic, Total	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Total (e) (s)	ug/L		48.7	30.1	29.9	18.8	42.4	34.0
Boron, Total	ug/L		159	ND(18.0)	88.8	146	101	<103
Cadmium, Total	ug/L	P118	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)
Calcium, Total (e) (s)	ug/L		10,400	3,770	3,580	8,470	4,180	6,080
Chromium, Total	ug/L	P119	ND(0.270)	ND(0.270)	0.810	0.340	0.900	<0.518
Cobalt, Total	ug/L		ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)	ND(0.660)
Copper, Total (e) (s)	ug/L	P120	8.59	6.14	6.62	4.33	15.5	8.24
Iron, Total (e) (s)	ug/L		332	284	194	114	525	290
Lead, Total (e) (s)	ug/L	P122	ND(0.620)	ND(0.620)	1.30	ND(0.620)	3.95	<1.42
Magnesium, Total (s)	ug/L		21,300	3,620	2,710	22,400	2,020	10,400
Manganese, Total (e) (s)	ug/L		22.4	19.8	8.22	7.32	21.9	15.9

(a) Sampling point location; see Figure 2-2 and Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-12 (Continued)

Analyte	Unit	Priority Pollutant Code	Final Combined Discharge (SP-16) (a) Day 1	Final Combined Discharge (SP-16) (a) Day 2	Final Combined Discharge (SP-16) (a) Day 3	Final Combined Discharge (SP-16) (a) Day 4	Final Combined Discharge (SP-16) (a) Day 5	Average Final Combined Discharge (SP-16) (a)
Mercury, Total	ug/L	P123	ND(0.0500)	ND(0.0500)	ND(0.0500)	0.0510	0.0510	<0.0504
Molybdenum, Total	ug/L		ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)	ND(1.60)
Nickel, Total (s)	ug/L	P124	10.4	9.88	12.3	6.76	17.6	11.4
Selenium, Total	ug/L	P125	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)	ND(1.40)
Silver, Total	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)
Sodium, Total (s)	ug/L		196,000	61,800	61,100	219,000	64,900	121,000
Tin, Total	ug/L		ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)
Titanium, Total	ug/L		ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
Vanadium, Total	ug/L		ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)
Zinc, Total (e) (s)	ug/L	P128	454	335	295	326	662	414
Aluminum, Dissolved	ug/L		ND(8.80)	ND(8.80)	ND(8.80)	ND(8.80)	73.8	<21.8
Antimony, Dissolved	ug/L	P114	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Arsenic, Dissolved	ug/L	P115	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)	ND(2.00)
Barium, Dissolved (e) (s)	ug/L		44.9	28.3	30.3	22.7	41.9	33.6
Beryllium, Dissolved	ug/L	P117	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)	ND(0.0700)
Boron, Dissolved (e)	ug/L		204	93.6	135	181	ND(18.0)	<126
Cadmium, Dissolved (e)	ug/L	P118	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)	ND(0.0800)
Calcium, Dissolved (s)	ug/L		12,700	3,760	3,830	9,910	4,210	6,880
Chromium, Dissolved	ug/L	P119	0.360	0.390	0.440	0.280	0.290	0.352
Cobalt, Dissolved (s)	ug/L		ND(0.660)	1.13	1.67	2.47	1.85	<1.56
Copper, Dissolved (s)	ug/L	P120	4.90	5.77	6.17	2.03	10.2	5.81
Iron, Dissolved (e)	ug/L		292	296	167	82.9	412	250

(a) Sampling point location; see Figure 2-2 and Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-12 (Continued)

Analyte	Unit	Priority Pollutant Code	Final Combined Discharge (SP-16) (a) Day 1	Final Combined Discharge (SP-16) (a) Day 2	Final Combined Discharge (SP-16) (a) Day 3	Final Combined Discharge (SP-16) (a) Day 4	Final Combined Discharge (SP-16) (a) Day 5	Average Final Combined Discharge (SP-16) (a)
Lead, Dissolved (e) (s)	ug/L	P122	1.72	1.05	0.770	ND(0.620)	2.43	<1.32
Magnesium, Dissolved (s)	ug/L		30,500	3,650	2,940	26,900	2,020	13,200
Manganese, Dissolved (s)	ug/L		21.4	22.2	11.3	12.3	24.2	18.3
Mercury, Dissolved	ug/L	P123	ND(0.0500)	ND(0.0500)	ND(0.0500)	0.0720	0.120	<0.0684
Nickel, Dissolved (s)	ug/L	P124	10.8	11.8	12.0	7.72	16.1	11.7
Silver, Dissolved	ug/L	P126	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)	ND(0.770)
Sodium, Dissolved (e) (s)	ug/L		283,000	68,700	62,000	246,000	61,200	144,000
Tin, Dissolved	ug/L		ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)	ND(0.940)
Titanium, Dissolved	ug/L		ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
Vanadium, Dissolved	ug/L		ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)	ND(0.470)
Zinc, Dissolved (s)	ug/L	P128	322	299	284	222	573	340
Volatile and Semivolatile Organics								
4-Chloro-3-methylphenol	ug/L	P022	ND(10.0)	ND(20.0)	ND(22.0)	ND(22.0)	ND(22.0)	ND(19.2)
Bis(2-ethylhexyl) phthalate	ug/L	P066	ND(10.0)	ND(20.0)	ND(22.0)	ND(22.0)	ND(22.0)	ND(19.2)
Chloroform (s)	ug/L	P023	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)
Diethyl phthalate	ug/L	P070	ND(10.0)	ND(20.0)	ND(22.0)	ND(22.0)	ND(22.0)	ND(19.2)
Phenol (e) (s)	ug/L	P065	66.0	40.0	72.0	49.0	38.0	53.0
Toluene	ug/L	P086	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)

(a) Sampling point location; see Figure 2-2 and Figure 2-3.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with three grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2. and Table 5-3 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-13

Treatment System Residuals and Incinerator Ash Analytical Results, Holland America Oosterdam

Analytical results for one-time grab samples of treatment system residuals (i.e., graywater screening solids, sewage/graywater screening solids, and sewage/graywater waste biosludge) and incinerator ash for analytes detected at least once in these samples. See Appendix A-2 for all analytical results (detected and nondetected). Figures 2-2 and 2-3 identify sampling point locations. See Table 3-2 for sample collection methodology. Also shown are average concentrations for the influents to the graywater and sewage/graywater treatment concentrations from Tables 4-2 and 4-7 for comparison. Certain treatment system residual results were converted from mass to volume units; see Section 3.3. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Priority Pollutant Code	Incinerator Ash (SP-10) (a)	Graywater Screening Solids (SP-15) (a)	Average Influent to GW Treatment (SP-6) (a)	Sewage/GW Screening Solids (SP-16) (a)	Sewage/GW Biosludge (SP-21) (a)	Average Influent to Sewage/GW Treatment (SP-11) (a)
Classical Pollutants							
Alkalinity		NC	1,130 mg/L	43.5 mg/L	ND(1,000) mg/L	ND(1,000) mg/L	558 mg/L
Chemical Oxygen Demand (COD) (s)		NC	15,200 mg/L	405 mg/L	2,390 mg/L	332 mg/L	2,220 mg/L
Chloride (s)		NC	79.8 mg/L	18.6 mg/L	97.4 mg/L	251 mg/L	127 mg/L
Nitrate/Nitrite (NO2-N + NO3-N) (s)		NC	2.20 mg/L	0.0360 mg/L	1.41 mg/L	8.33 mg/L	0.0268 mg/L
Sulfate (s)		NC	486 mg/L	10.8 mg/L	498 mg/L	1,600 mg/L	123 mg/L
Total Kjeldahl Nitrogen (TKN) (s)		NC	733 mg/L	9.08 mg/L	9.87 mg/L	1,260 mg/L	193 mg/L
Total Organic Carbon (TOC) (s)		NC	9,960 mg/L	53.4 mg/L	756 mg/L	4,060 mg/L	265 mg/L
Total Phosphorus		NC	53.0 mg/L	1.70 mg/L	15.8 mg/L	192 mg/L	24.7 mg/L
Total and Dissolved Metals							
Aluminum, Total		43,500 mg/kg	131,000 ug/L	744 ug/L	3,590 ug/L	22,400 ug/L	1,330 ug/L
Antimony, Total	P114	6.92 mg/kg	260 ug/L	ND(2.00) ug/L	ND(0.00630) ug/L	ND(0.00420) ug/L	ND(2.00) ug/L
Arsenic, Total	P115	4.37 mg/kg	ND(0.0771) ug/L	ND(2.00) ug/L	9.87 ug/L	5.60 ug/L	ND(2.00) ug/L
Barium, Total (s)		427 mg/kg	49,600 ug/L	135 ug/L	1,010 ug/L	3,790 ug/L	264 ug/L
Beryllium, Total	P117	0.350 mg/kg	ND(0.00257) ug/L	ND(0.0700) ug/L	ND(0.000210) ug/L	ND(0.000140) ug/L	ND(0.0700) ug/L

(a) Sampling point location; see Figure 2-2 and Figure 2-3.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-13 (Continued)

Analyte	Priority Pollutant Code	Incinerator Ash (SP-10) (a)	Graywater Screening Solids (SP-15) (a)	Average Influent to GW Treatment (SP-6) (a)	Sewage/GW Screening Solids (SP-16) (a)	Sewage/GW Biosludge (SP-21) (a)	Average Influent to Sewage/GW Treatment (SP-11) (a)
Boron, Total		324 mg/kg	ND(0.118) ug/L	<29.3 ug/L	676 ug/L	626 ug/L	<54.7 ug/L
Cadmium, Total	P118	0.330 mg/kg	23.9 ug/L	ND(0.0800) ug/L	2.52 ug/L	7.00 ug/L	0.394 ug/L
Calcium, Total (s)		179,000 mg/kg	568,000 ug/L	1,680 ug/L	44,300 ug/L	103,000 ug/L	11,000 ug/L
Chromium, Total	P119	71.7 mg/kg	3,060 ug/L	5.25 ug/L	134 ug/L	253 ug/L	8.44 ug/L
Cobalt, Total		18.2 mg/kg	ND(0.0103) ug/L	ND(0.660) ug/L	ND(0.000840) ug/L	ND(0.000560) ug/L	ND(0.660) ug/L
Copper, Total (s)	P120	920 mg/kg	33,200 ug/L	213 ug/L	1,090 ug/L	6,900 ug/L	451 ug/L
Iron, Total (s)		8,530 mg/kg	272,000 ug/L	374 ug/L	4,310 ug/L	13,800 ug/L	1,250 ug/L
Lead, Total (s)	P122	14.2 mg/kg	1,600 ug/L	7.38 ug/L	3.19 ug/L	153 ug/L	10.0 ug/L
Magnesium, Total (s)		8,900 mg/kg	37,500 ug/L	471 ug/L	6,740 ug/L	32,800 ug/L	3,820 ug/L
Manganese, Total (s)		450 mg/kg	1,720 ug/L	7.85 ug/L	170 ug/L	554 ug/L	60.0 ug/L
Mercury, Total	P123	ND(0.0200) mg/kg	8,740 ug/L	<0.0580 ug/L	ND(0.000420) ug/L	3.50 ug/L	0.220 ug/L
Molybdenum, Total		15.5 mg/kg	414 ug/L	ND(1.60) ug/L	20.6 ug/L	55.9 ug/L	<1.91 ug/L
Nickel, Total (s)	P124	97.4 mg/kg	3,340 ug/L	17.1 ug/L	101 ug/L	192 ug/L	27.9 ug/L
Selenium, Total	P125	ND(0.230) mg/kg	170 ug/L	ND(1.40) ug/L	7.35 ug/L	37.5 ug/L	<2.27 ug/L
Silver, Total	P126	18.0 mg/kg	1,430 ug/L	<1.37 ug/L	12.4 ug/L	55.4 ug/L	2.91 ug/L
Sodium, Total (s)		30,800 mg/kg	504,000 ug/L	21,300 ug/L	125,000 ug/L	137,000 ug/L	85,100 ug/L
Tin, Total		29.3 mg/kg	ND(0.0925) ug/L	<2.46 ug/L	288 ug/L	339 ug/L	7.56 ug/L
Titanium, Total		2,660 mg/kg	1,370 ug/L	2.04 ug/L	ND(0.0298) ug/L	153 ug/L	3.02 ug/L
Vanadium, Total		96.6 mg/kg	910 ug/L	<0.696 ug/L	8.40 ug/L	32.8 ug/L	<1.16 ug/L
Yttrium, Total		2.73 mg/kg	ND(0.0154) ug/L	ND(0.310) ug/L	ND(0.00126) ug/L	1.11 ug/L	ND(0.310) ug/L
Zinc, Total (e) (s)	P128	572 mg/kg	177,000 ug/L	791 ug/L	4,050 ug/L	21,400 ug/L	1,790 ug/L

(a) Sampling point location; see Figure 2-2 and Figure 2-3.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-13 (Continued)

Analyte	Priority Pollutant Code	Incinerator Ash (SP-10) (a)	Graywater Screening Solids (SP-15) (a)	Average Influent to GW Treatment (SP-6) (a)	Sewage/GW Screening Solids (SP-16) (a)	Sewage/GW Biosludge (SP-21) (a)	Average Influent to Sewage/GW Treatment (SP-11) (a)
Volatile and Semivolatile Organics							
Bis(2-ethylhexyl) phthalate	P066	ND(170) ug/kg	20,100 ug/L	<15.0 ug/L	ND(168) ug/L	59.0 ug/L	56.4 ug/L
Chloroform (s)	P023	NC	5.74 ug/L	ND(5.00) ug/L	ND(4.92) ug/L	ND(0.0700) ug/L	ND(5.00) ug/L
Ethylbenzene	P038	NC	13.1 ug/L	ND(5.00) ug/L	ND(4.92) ug/L	ND(0.0700) ug/L	ND(5.00) ug/L
Phenol (e) (s)	P065	250 ug/kg	ND(8,370) ug/L	49.4 ug/L	ND(168) ug/L	380 ug/L	94.4 ug/L
Toluene	P086	NC	19.1 ug/L	<5.20 ug/L	21.7 ug/L	ND(0.0700) ug/L	<6.00 ug/L
Dioxins and Furans							
1,2,3,4,6,7,8-HpCDF		6.00 pg/g	NC	NC	NC	NC	NC
1,2,3,4,7,8-HxCDF		5.20 pg/g	NC	NC	NC	NC	NC
2,3,7,8-TCDF		5.70 pg/g	NC	NC	NC	NC	NC
Octachlorodibenzo-p-dioxin		12.5 pg/g	NC	NC	NC	NC	NC

(a) Sampling point location; see Figure 2-2 and Figure 2-3.
(s) Analyte detected at some level in the source water. See Section 4.1.12 and Table 4-14 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-14

Source Water Analytical Results, Holland America Oosterdam

Analytical results for one-time grab sample of source water for detected analytes. See Appendix A-2 for all analytical results (detected and nondetected). Also shown are Federal drinking water standards for comparison. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Source Water (SP-17) (a) Day 2	Federal Drinking Water Standards (b)
Classical Pollutants				
Chemical Oxygen Demand (COD)	mg/L		28.0	
Chloride	mg/L		4.40	250
Hardness	mg/L		2.91	
Nitrate/Nitrite (NO2-N + NO3-N)	mg/L		0.0160	10 (Nitrate) 1 (Nitrite)
Sulfate	mg/L		13.9	250
Total Kjeldahl Nitrogen (TKN)	mg/L		0.320	
Total Organic Carbon (TOC)	mg/L		1.05	
Total and Dissolved Metals				
Barium, Total	ug/L		185	2,000
Calcium, Total	ug/L		1,000	
Copper, Total	ug/L	P120	193	1,300
Iron, Total	ug/L		118	300
Lead, Total	ug/L	P122	42.8	0
Magnesium, Total	ug/L		96.8	
Manganese, Total	ug/L		2.67	50
Nickel, Total	ug/L	P124	66.0	
Sodium, Total	ug/L		6,640	
Zinc, Total	ug/L	P128	1,140	5,000
Barium, Dissolved	ug/L		181	
Calcium, Dissolved	ug/L		912	
Cobalt, Dissolved	ug/L		2.30	
Copper, Dissolved	ug/L	P120	14.0	
Lead, Dissolved	ug/L	P122	0.790	

(a) Sampling point number; see Table 2-1.
(b) 40 CFR 141.62 National Primary Maximum Contaminant Levels for Inorganic Contaminants (nitrate/nitrite, barium); 40 CFR 141.51 National Primary Maximum Contaminant Level Goals for Inorganic Contaminants (copper, lead); and 40 CFR 143.3 Secondary Maximum Contaminant Levels (chloride, sulfate, iron, manganese, zinc).

Table 4-14 (Continued)

Analyte	Unit	Priority Pollutant Code	Source Water (SP-17) (a) Day 2	Federal Drinking Water Standards (b)
Magnesium, Dissolved	ug/L		92.9	
Manganese, Dissolved	ug/L		4.09	
Nickel, Dissolved	ug/L	P124	3.62	
Sodium, Dissolved	ug/L		3,880	
Zinc, Dissolved	ug/L	P128	24.9	
Volatile and Semivolatile Organics				
Chloroform	ug/L	P023	24.0	
Phenol	ug/L	P065	58.0	

(a) Sampling point number; see Table 2-1.
(b) 40 CFR 141.62 National Primary Maximum Contaminant Levels for Inorganic Contaminants (nitrate/nitrite, barium); 40 CFR 141.51 National Primary Maximum Contaminant Level Goals for Inorganic Contaminants (copper, lead); and 40 CFR 143.3 Secondary Maximum Contaminant Levels (chloride, sulfate, iron, manganese, zinc).

Table 4-15

Flow Data by Sampling Period, Holland America Oosterdam

Flow data collected via strap-on ultrasonic flow meters installed by the sampling team. Figures 2-1 through 2-3 show the flow meter locations. Flow per capita was calculated by dividing the daily flow totals by the number of passengers and crew (2,625 people) onboard the Oosterdam during the sampling episode. Daily flow per capita was not calculated for accommodations because accommodations wastewater flows were measured for only one of six accommodations wastewater holding tanks.

Sampling Period	Total Daily Flow (m^3)										
	Accommodations (SP-1)(a)	Influent to Graywater Treatment System (SP-6)(a)		Effluent from Graywater Treatment System (SP-8)(a)		Influent to Sewage/Graywater Treatment System (SP-11)(a)		Effluent from Sewage/Graywater Treatment (SP-13)(a)		Final Combined Treated Effluent (SP-16)(a)	
	Daily Total Flow, gallons/day (m^3/day)	Daily Total Flow, gallons/day (m^3/day)	Daily Flow Per Capita gallons/ day/person (m^3/day/ person)	Daily Total Flow, gallons/day (m^3/day)	Daily Flow Per Capita gallons/ day/person (m^3/day/person)	Daily Total Flow, gallons/day (m^3/day)	Daily Flow Per Capita gallons/ day/person (m^3/day/person)	Daily Total Flow, gallons/day (m^3/day)	Daily Flow Per Capita gallons/ day/person (m^3/day/person)	Daily Total Flow, gallons/day (m^3/day)	Daily Flow Per Capita gallons/ day/person (m^3/day/ person)
Day 1	4,040 (15.3)	75,700 (287)	28.8 (0.109)	43,600 (165)	16.6 (0.0629)	65,700 (249)	25.0 (0.0947)	43,900 (166)	16.7 (0.0633)	35,500 (134) (b)	13.5 (0.0512) (b)
Day 2	5,190 (19.7)	84,300 (319)	32.1 (0.122)	61,000 (231)	23.2 (0.0880)	66,400 (251)	25.3 (0.0957)	44,200 (167)	16.9 (0.0638)	106,000 (400)	40.3 (0.152)
Day 3	1,830 (6.92)	78,500 (297)	29.9 (0.113)	56,000 (212)	21.3 (0.0808)	62,500 (237)	23.8 (0.0902)	41,600 (158)	15.9 (0.0600)	114,000 (430)	43.3 (0.164)
Day 4	2,600 (9.84)	78,100 (296)	29.8 (0.113)	NR	NC	53,100 (201)	20.2 (0.0766)	36,500 (138)	13.9 (0.0526)	89,600 (339) (b)	34.1 (0.129) (b)
Day 5	4,230 (16.0)	88,900 (337)	33.9 (0.128)	NR	NC	52,700 (200)	20.1 (0.0760)	40,600 (154)	15.5 (0.0585)	137,000 (519)	52.3 (0.198)
Average	3,580 (13.5)	81,000 (307)	30.9 (0.117)	53,600 (203)	20.4 (0.0774)	60,100 (227)	22.9 (0.0867)	41,400 (157)	15.8 (0.0597)	119,000 (450) (b)	45.3 (0.171) (b)

(a) Sampling point number; see Figures 2-1 through 2-3.
(b) Average daily discharge flow rate for final combined treated effluent excludes data from Day 1 and 4 when the Oosterdam suspended discharge while in Washington waters and while cruising Hubbard Glacier.
NC - Not calculated.
NR - Not recorded, see Section 4.3.

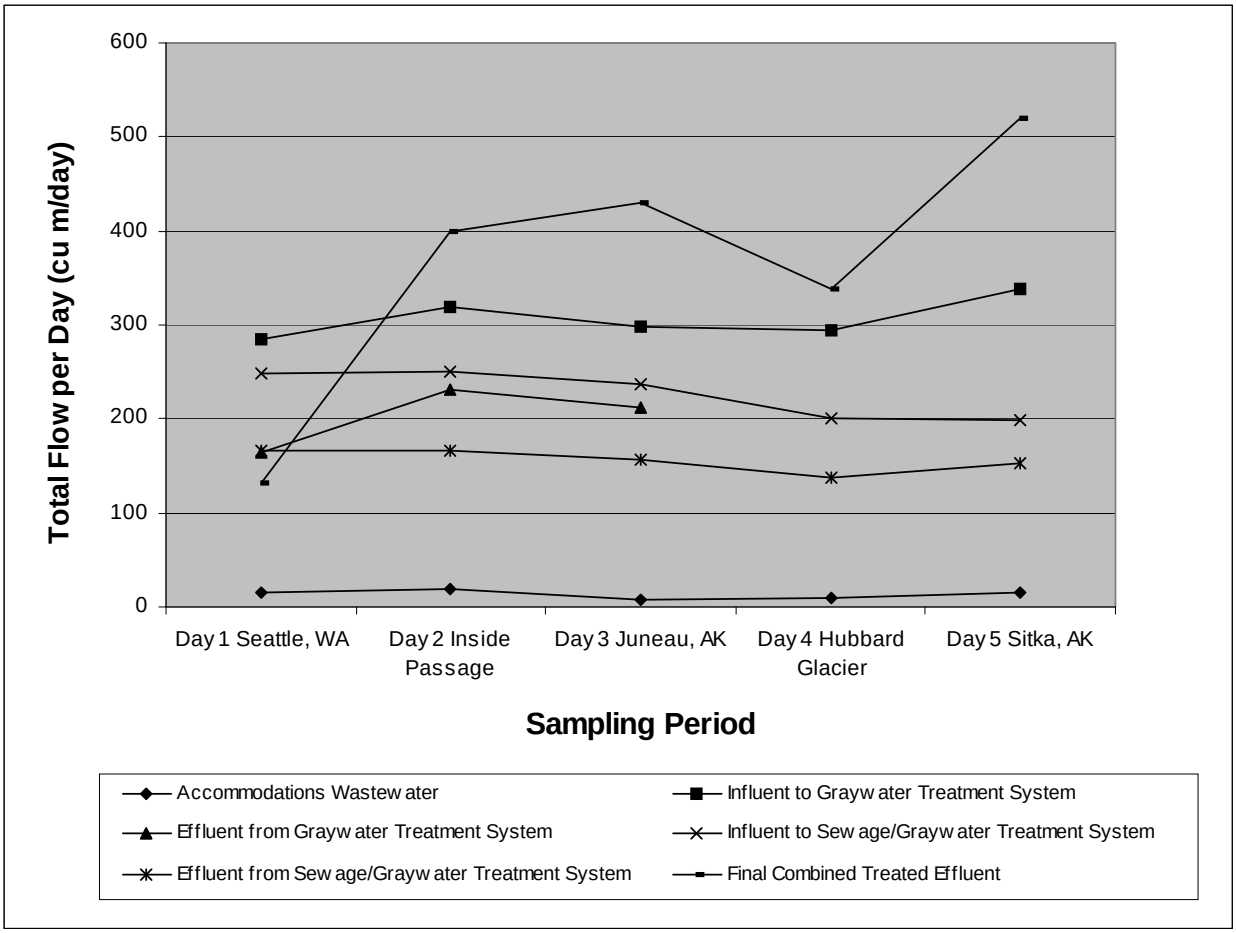

Figure 4-1. Total Daily Flow, Holland America Oosterdam

Flow data collected via strap-on ultrasonic flow meters installed by the sampling team. Flow data are presented as daily totals for each location. Figures 2-1 through 2-3 show the flow meter locations.

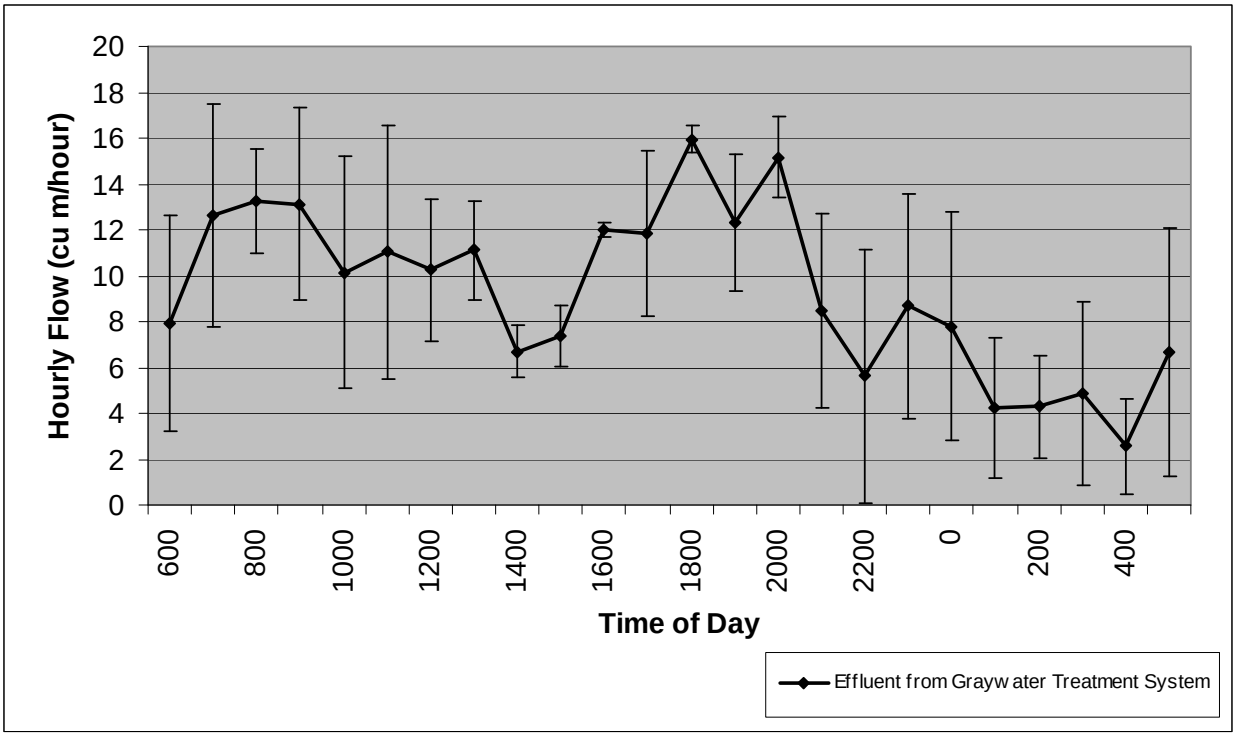

Figure 4-2. Average Hourly Graywater Treatment System Flow, Holland America Oosterdam

Average effluent flow for each hour interval over the three consecutive 24-hour sampling periods, calculated and plotted from the strap-on flow meter installed by the sampling team. Figure 2-2 shows the flow meter location. Bars represent the standard error of the hourly flow calculated for the three consecutive sampling days. Standard error is calculated as the standard deviation divided by the square root of the number of hourly flow measurements (three).

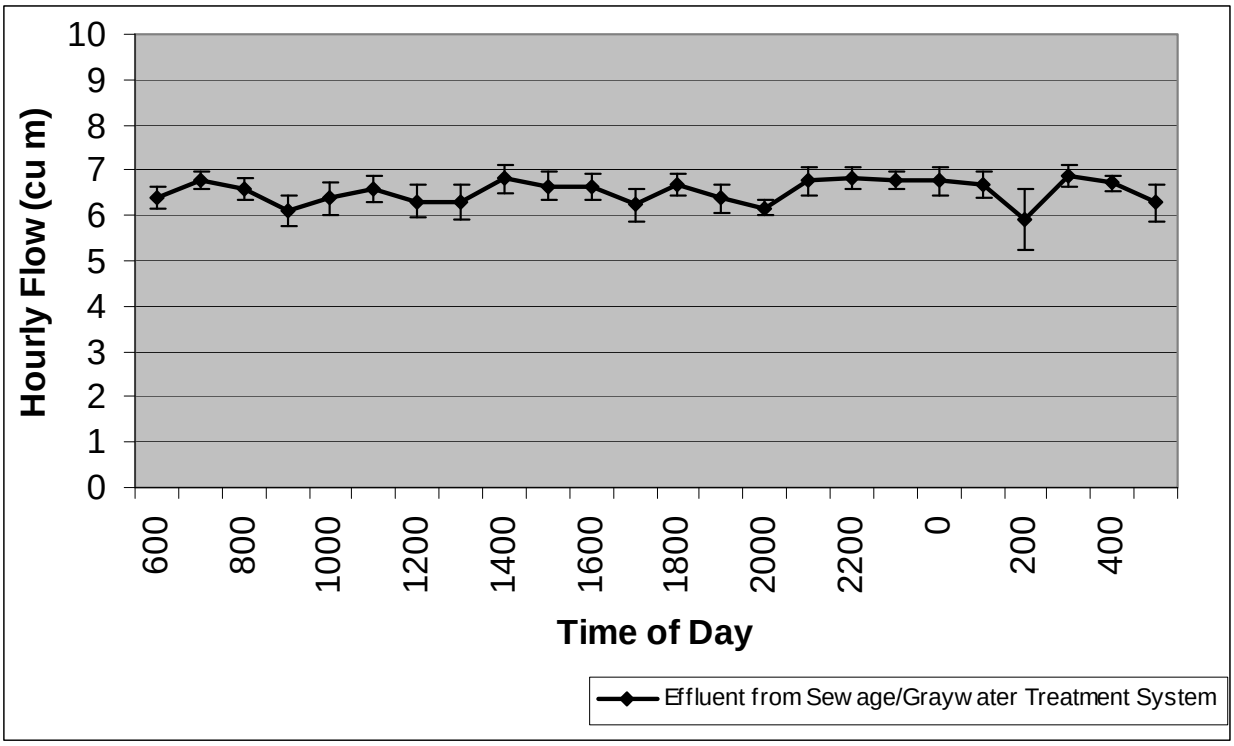

Figure 4-3. Average Hourly Sewage/Graywater Treatment System Flow, Holland America Oosterdam

Average effluent flow for each hour interval over the five consecutive 24-hour sampling periods, calculated and plotted from the strap-on flow meter installed by the sampling team. Figure 2-1 shows the flow meter location. Bars represent the standard error of the hourly flow calculated for the five consecutive sampling days. Standard error is calculated as the standard deviation divided by the square root of the number of hourly flow measurements (five).